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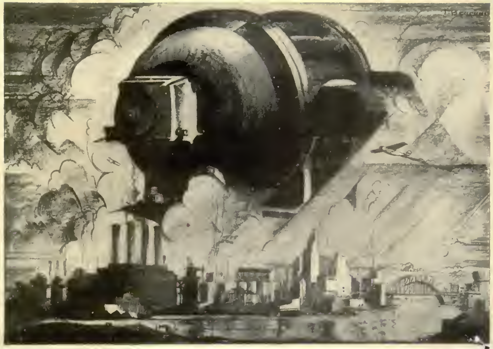

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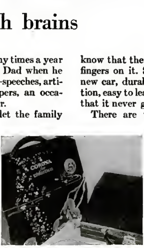

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CORONA

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"GIMMIE A TIP"

By WALLACE AMES, *Financial Editor*

"YOU'RE in Wall Street . . . tell me something good. I've got $500 and I want to run it up to around $1,500 within the next two or three months. What'll I buy?"

In such words was the Financial Editor of Popular Science Monthly recently greeted. Some readers may see a tincture of humor in this modest ambition to triple a sum of money in three months. Hardly a day passes, however, without just such a question being put seriously to practically every man whose occupation is in the financial field. How should such a question be answered?

First, let's see how the "experts" judge the stock market. The following was published in the New York Sun during September: "The investor or speculator who reads the advice obtained from commission house letter writers will find enough contradiction in today's assortment to make his head swim. About as many assert confidently that the next trend will be upward as are positive that the market is going lower."

Stock brokers desire to supply their customers with dependable information. They maintain staffs of trained statisticians and analysts; these men have access to every conceivable form of official data; their sole occupation is to study trends and values. And yet—not only occasionally, but almost invariably there is a wide divergence of opinion among stock market experts.

Higgledy-Piggledy

Omitting the names of their authors, we quote below excerpts from brokers' market letters which were published the day that the above mentioned item appeared in the Sun. Each quotation represents an expert opinion. Read them in order and note the contrast.

"Look for gradual drift to lower levels."

(*The market*) "*gave impressive evidence of its ability to work higher.*"

"Correction has now gone far enough to warrant moderately bullish attitude on high grade stocks."

"*We suggest the lightening of accounts.*"

"The action of the market Friday gave strong indications that readjustment of its technical position has been practically completed."

"*This week's increase in brokers' loans is disappointing.*"

"Stocks were meeting with strong support."

"*We see no real check in the selling movement.*"

"After a period of irregularity the upward trend will be resumed."

"*The preponderant trend for the immediate future will be downward.*"

(The market) "Will shortly resume its former buoyancy."

"*The market as a rule should be liquidated on rallies.*"

October 3 witnessed one of the most perpendicular declines in the history of the New York Stock Exchange. During the previous day prices were advancing. The following opinions as to the immediate future trend appeared the *same day* that the decline was in progress:

"The lows have been temporarily reached."

"*A secondary reaction is coming after the present forward thrust.*"

"The market acts as though it were trying to go up."

"*Stocks will be offered for sale on every bulge.*"

"The current rally in the market will continue further."

(*We are*) "*not inclined to follow the current rally as yet.*"

Just the day before such a drastic decline as occurred October 3 there was a wide conflict of opinion among experts as to what was going to happen and many advisers were taken completely by surprise, as the above quotations show.

Vague-ries

A common characteristic of brokerage advice is its vagueness . . . probably the result of doubt or lack of conviction on the broker's part as to future trends. As a vague suggestion, "Maintain a trading position" is a popular favorite. And what, for example, do you get from the following quotations which were also taken from opinions published in the Sun. What action would these advices suggest to you?

"Seek out new favorites."

(We want to see) "more evidence of vigorous buying in stocks of investment calibre."

"As has been the case for the last six months, the market problem continues to be one of proper selection."

"Breaks in many directions would still suggest the probability of further correction."

(We are) "in favor of a more inviting market for trading commitments."

"Special development will probably play a larger part in the market of the immediate future."

It would seem that such opinions as quoted represent groping for a clue as to the immediate future trend rather than an appraisal of intrinsic values. And that, by the way, is one difference between speculating and investing. The speculator is guided largely by what he thinks, or what someone else thinks is going to happen; he would buy a stock of no value whatever, if convinced he could sell it at a profit. The investor, on the other hand, while harboring a desire to see his securities go up is actuated in his selections by known values.

The goose-bone prophet who predicts rain every day will sooner or later be right. The professional stock market advisor, who is passing out opinions all the time is bound to be right part of the time. But where does that leave you?

A prominent figure created considerable stir early in August of 1929 by predicting a 50- or 60-point break in stock market averages. Perhaps the September decline was severe enough so that we may regard his prediction as realized in a practical sense. But even the September decline only wiped out about 65% of the advance that occurred during August in the wake of the bearish forecast.

In a speculative effort there is a deal of difference between *thinking* and *acting*. A thousand experts may *think* the market is going up. Simultaneously, another thousand may *think* it is going down. But when you have $500, $1,000 or some other definite sum with which to take a market whirl, you can't just "think" about securities . . . you must take some action. Seeking speculative advice leaves you confused and confounded . . . you finally act in the dark. Note we said *speculative* advice, which is a different thing than investment advice.

It is so easy to forget that either investing or speculating in securities is a forward-looking process. People confuse reflection with vision. They recall the former prices of Atchison, American Tel. & Tel., General Electric and other so called "blue chips." . . . They figure out the profits that might

(*Continued on page 5*)

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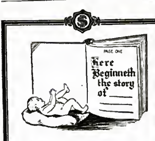
PAGE ONE
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"GIMMIE A TIP"

(Continued from page 4)

have been made. Then they indulge in a few mental contortions: "If I buy this or that, and if it goes up like so and so to such and such a price . . . presto . . . I have tripled my money." You can always figure out how you *might* have made a killing, but figuring *ahead* is not simple . . . free advice notwithstanding.

The statistician of a prominent Stock Exchange firm designed a series of charts which proved that a certain stock was a good purchase around 112, at which price it was then selling. The stock did reach a high point of 135 during 1929 . . . but it's now around 50. If you could have called the turn you could have made money on this statistician's advice. But when experts disagree so violently as to the trend of the whole market, what chance have you to call the turn on an individual stock? And where would you have been had you bought this particular stock at 112 to hold for investment? You would have been in for the long pull . . . with emphasis on the *long pull*.

There lies before us a copy of a financial daily. A front-page article bears this caption: "Stay Out, Advice Given by Brokers. Most Think the Market too Uncertain to Warrant New Commitments." In the light of the rest that we have written this comes under the classification of sound advice. But the article was printed October 1—after the September decline—a bit too late to save the profits of most speculators who depend on professional opinion.

Following are eight stocks, one pair representing each of four industries. In each case one of the pair went up during September; the other registered a decline. The figures show the changes in price which took place between August 31 and September 30, 1929.

Allied Chemical, declined 35 points
Commercial Solvents, advanced 124½ points
General Foods, declined 6¾ points
National Biscuit, advanced 5½ points
Standard Oil (Cal.), declined 2¾ points
Standard Oil (N. J.), advanced 2 points
Consolidated Gas, declined 18 points
Columbia Gas and Elec., advanced 24½ points

In the above cases the speculator who thought chemicals were good won if he picked Commercial Solvents; he lost if he chose Allied Chemical. If he favored the utilities he won on Columbia or lost on Consolidated.

This is the way a tip usually works out: Mr. A. is advised to buy So-and-So and is primed as to what is going to happen in that stock. He watches it; it goes up; then he buys near the top *and watches the price decline*. More people buy stocks *after* they have gone up than before. It is a peculiar quirk of human nature.

Another characteristic of the human race is to like to pass along "inside dope." If you could trace to its origin any one of the tips you get you would be surprised at its long string of ancestry and the doubtful character of its parents.

Putting all these facts and illustrations together brings us to only one conclusion. Following speculative advice is a hazardous undertaking—about as hazardous as speculating in the dark.

But what to do? Invest—don't speculate. Buy known values—not bunches. Put your money in something you are willing to keep and you'll have more money in the end.

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(Continued on page 6)

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"GIMMIE A TIP"

(Continued from page 8)

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Statement of Ownership, Management, Circulation, etc., required by the Act of Congress of August 24, 1912 of Popular Science Monthly, published monthly at New York, N. Y., for October 1, 1929, State of New York, County of New York, ss. Before me, a notary public in and for the State and county aforesaid, personally appeared O. B. Capen, who, having been duly sworn according to law, deposes and says that he is the Business Manager of Popular Science Monthly and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 411, Postal Laws and Regulations, printed on the reverse of this form to wit:

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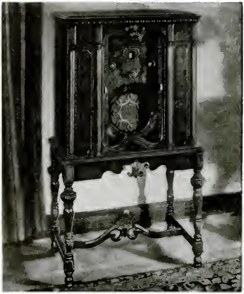

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Tools, Radio Apparatus, Oil Burners and Refrigerators advertised in POPULAR SCIENCE MONTHLY have been tested or investigated by the Popular Science Institute of Standards and each advertisement carries the insignia indicating approval.

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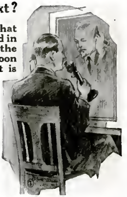

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2. Are the stars solid like the earth? ______
3. How was the earth formed? ______
4. Why is glass transparent? ______
5. How do we know that the earth is slowly shrinking? ______
6. What is an electric current? ______
7. How was petroleum formed? ______
8. Do electrons really move through wire when an electric current is flowing through it? ______
9. What physical changes in your body are produced by fear? ______
10. How do muscles exert power? ______
11. What are X-rays? ______
12. Can we see atoms with a microscope? ______
13. Why does heat expand things and cold contract them? ______
14. Why does the moon appear to change its shape from time to time? ______
15. What is the brain made of? ______
16. Why is it possible that the inside of the earth is growing hotter instead of colder? ______
17. Why is frost more likely on a clear night than on a cloudy one? ______
18. Does thinking use up the thinker's energy? ______
19. Which travels faster, electricity or light? ______
20. What simple test will distinguish wool from cotton? ______
21. What makes the noise of thunder? ______
22. Why would men ultimately suffocate if all the green plants were killed? ______
23. Does the boiling of water remove the impurities in it? ______
24. How do the living cells of the body get the energy with which to do their work? ______
25. How is the speed of light measured? ______

TOTAL PERCENTAGE ______

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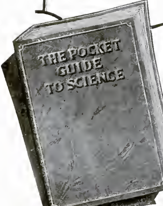

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APPROVED · BY · POPULAR · SCIENCE · INSTITUTE

A Letter to the Institute Will Bring Sound Advice on Buying Equipment of the Highest Value

By F. G. PRYOR

Secretary, Popular Science Institute

ADVICE is cheap enough and there are always plenty of people ready to offer it, as any buyer knows. The remarkable part is that so many of these people can say very definitely and conclusively just which make of product is "the best." As a rule, the more limited their knowledge, the more positive they can be in their assertions.

We on the Popular Science Institute staff get considerable amusement in occasionally overhearing some of the counsel that is given to prospective buyers. A commuters' train was the scene of a typical discussion the other morning, refrigerators being the subject. One man was telling his neighbor that a certain electric refrigerator "had it all over" all the other electric refrigerators on the market—was cheaper to operate, more efficient and superior in every way. As far as we were able to gather, this gentleman's knowledge of the refrigerator in question was based more or less exclusively on his own experience, that of his brother-in-law, and some friends who were owners of refrigerators of the automatic type. As it happened, the refrigerator he was praising was a very fine make but it was not better than several other excellent refrigerators now on the market.

What the Institute Found

SOMETIMES, people are skeptical when we tell them that there is no one outstanding refrigerator on the market today that can be considered "the best." But this is a definite fact proved by the test information on file at The Institute's laboratory at New York University—and this information provides a somewhat more accurate basis for an opinion than the experience of a few users of refrigerators.

Every test that Popular Science Institute makes on a refrigerator of the automatic type requires a minimum of twelve weeks' time, test runs being made at six different temperatures and all features of construction and operation receiving careful check. An idea of the extent of these tests and the complete nature of the data obtained may be gathered from the fact that one of the few commercial laboratories in the country that is equipped to make similar tests charges $750 for putting a refrigerator through just one part of the series of tests to which Popular Science Institute subjects all refrigerators.

The "Cream" of the Market

SIMILARLY, in the case of the other types of products that The Institute investigates—radio, tool, and oil heating equipment—it has been found that invariably a small group of very fine products rather than one single product that could be considered most superior, is at the top. Between products of such equivalent merit, any selection of the best would come down to a matter of opinion, and Popular Science Institute feels that it is the buyer's opinion that counts when such a scant margin of choice is involved. When making a selection from among a limited number of products whose merit and value have been established by careful test, satisfaction is bound to result in any case, and the highest degree of satisfaction will result when the basis of choice has been the buyer's personal preferences and requirements.

Therefore, when a prospective buyer uses Popular Science Institute's approved list as a guide in buying, he is absolutely protected and certain to get well made equipment that represents good value and will give satisfactory service. The Institute's knowledge of the merits of equipment in the four classes of products it investigates is based on the complete facts in every case, and its decisions as to which makes deserve approval are absolutely impartial.

Where the Tests Are Made

THE Sage Research Laboratory at New York University, with its $350,000 worth of testing equipment, is the Popular Science Institute's testing headquarters. Every product is put through most severe laboratory and practical test, and every essential fact that need be known about the product is determined. The tests are made by engineering experts with exceptional experience and ability.

Products are approved solely on the basis of test and investigation findings, all decisions being in the hands of Dean Collins P. Bliss of New York University, who is Director of Popular Science Institute. Professor Bliss is Associate Dean of the College of Engineering at New York University and is on the staff of the United States Bureau of Standards in Washington as consulting mechanical engineer.

Price Is a Factor

POPULAR SCIENCE INSTITUTE does not confine its approvals to products in only one price class. What it insists on is that equipment represent good value and be up to the standards for its own price class. Of course, in all types of equipment, there is a price limit below which no worth while product can be manufactured, and Popular Science Institute will not grant its approval to a low priced product unless the manufacturer has been able to turn out a device for that price which is really well made and capable of giving lasting satisfaction to the purchaser.

Use the Institute Service

The Popular Science Institute is first and last a service for the readers of POPULAR SCIENCE MONTHLY. Its aim is to safeguard them in their purchases of equipment of technical or semi-technical nature. In order that The Institute may function with greatest efficiency and widest usefulness, readers of this magazine are urged to make full use of its service.

Sound advice and lists of reliable makes of radio, tool, oil heating and refrigerating equipment will be supplied on request. Special questions pertaining to the purchase of such equipment will be answered gladly. Address Popular Science Institute, 381 Fourth Ave., New York.

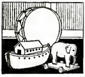
INSTITUTE BULLETINS

- List of Approved Tools
- Insulation in Building Construction*
- List of Approved Radio Products
- List of Approved Oil Heating Devices
- Advice on Installing Oil Heat
- List of Approved Refrigerators
- Refrigeration for the Home*

*Price 25 cents each

For toys at Christmas time, for industry all the time ...this *grainless* wood board

The discovery of a method to make wood grainless is revolutionizing many industrial processes, is giving manufacturers a new material with which to improve products and reduce costs. Perhaps you, too, can profitably use this grainless wood. A sample and the Presdwood booklet are yours for the asking. Both are FREE.



FOR CHILDREN'S CHRISTMAS TOYS

Now tiny tots can play with wooden toys that will not splinter. Motor truck bodies are made strong and smooth with a material that neither cracks nor splits. Glistening concrete walls of towering skyscrapers require practically no hand smoothing because of a perfect, smooth board that lines the forms. All these developments, and scores of others in manufacturing and building, are possible today because of the grainless wood board, Masonite Presdwood.

Manufacturers find that Presdwood has many properties which adapt it to production methods. Builders find its smooth surface, its uniform $\frac{1}{8}$th inch thickness, and its broad four foot by twelve foot pieces ideal for paneling, display booths, closet lining, breakfast nooks, and for lining ventilator and elevator shafts.

Easily worked—in factory or home

While the grainless nature of Presdwood is perhaps its most remarkable feature, it is far from the only property which makes Presdwood popular. This grainless wood is hard, smooth, strong, and dense. It never harms fine tools; it can be punched, die cut, milled, or sanded; it is also ideal for the home mechanic who has little to work with but a hammer and saw. And when an article is completed it can be left just as it is because of Presdwood's natural beauty and resistance to moisture, or can be given any commercial finish.

FOR LINING CONCRETE FORMS

This grainless wood is used in radio cabinets, tension boards for loud speakers, beds of portable billiard tables, book cases, kitchen cabinets, show cases, and china closets. It makes strong shipping containers, weather resisting road signs, light partitions, durable work bench tops, and attractive novelties such as bedroom screens, fire screens, and trays.

Lines concrete forms

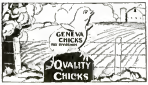
Building contractors reduce labor costs on concrete work as much as 40 per cent when Presdwood lines the forms, for the face of Presdwood leaves the concrete perfectly smooth so that the process of polishing with carborundum bricks can be entirely eliminated.

Every manufacturer, builder, and home mechanic should read the fascinating story of wood made grainless. It is the record of a scientific experiment with live steam at 1,000 pounds pressure—an experiment which revealed a way to make grainless wood commercially.

The Presdwood booklet tells this story, lists 80 uses for this grainless wood, and tells how various finishes should be applied. The booklet and a sample of Presdwood are yours for the asking. A postcard brings them.

MASONITE CORPORATION
Dept. 732, 111 West Washington Street
Chicago, Illinois

FOR WEATHER RESISTING SIGNS



Masonite
PRESDWOOD
Made by the makers of
MASONITE STRUCTURAL INSULATION

FOR STURDY SHIPPING CONTAINERS

© 1929 M. C.

Our Readers Say

Do You Agree?

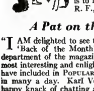
"WHY do you and others persist in using the awkward and confusing word 'noninflammable'? Bearded etymologists may produce all sorts of justifications for this word, but sensible and practical people usually avoid it because its meaning is so cloudy. To the average person, 'flammable' means something that can be burned. 'Inflammable,' then, naturally should mean something that cannot be burned. 'Noninflammable', therefore, suggests a double negative having the same meaning as 'flammable'—exactly opposite to the meaning intended by its users. The word is not wrong structurally, but it is stupid because of its unnecessary repetition, and it violates common sense.

"If your writers like 'large, round words', may I suggest 'incombustible' as conveying the meaning that 'noninflammable' so impotently strives to impart."—A. R. M., Detroit, Mich.

POPULAR SCIENCE MONTHLY, *not persistent philologically, holds no brief for awkward "noninflammable." But are there no arguments on the other side?*

Something to Worry About

"IN ONE paragraph of your recent article on digger wasps the writer says large numbers of the wasps may be liberated to fight injurious caterpillars. Later, he states that when the wasps first hatch out they live on fruit juices.



"What I want to know is how they get the juices without harming the fruit, and how farmers will be better off with swarms of wasps eating their fruit than they are now with caterpillars eating the leaves. My advice is to let Nature alone."—R. F., Columbus, Ohio.

A Pat on the Back

"I AM delighted to see that you are making 'Back of the Month's News' a regular department of the magazine. It is one of the most interesting and enlightening features you have included in POPULAR SCIENCE MONTHLY in many a day. Karl Vooght possesses the happy knack of chatting about scientific subjects in such a manner as to both instruct and entertain the lay reader and that, unless I am mistaken, is the real attraction of your publication."—H. A. McK., Omaha, Neb.

What! No Science in Cockleburrs?

"BARNSTORMING with Lindbergh," by Randy Enslow, was a nicely written and entertaining article and one which is sure to give some pleasurable moments, especially to your younger readers. But may an oldster like myself, who has been an interested reader of POPULAR SCIENCE MONTHLY for nearly twenty years, be permitted to ask why you considered it a suitable contribution to your particular magazine and 'played it up' in the bargain? Of the popularity of this sort of yarn there can be little doubt, but by what stretch of editorial imagination could it be called scientific?

"It seems to me that little, if anything, is added to the sum total of human knowledge by telling the world that Lindbergh at one time regarded the placing of cockleburrs in people's beds in the light of good, clean fun, and that he was an exemplary boy who never drank, swore, or smoked.

"An article like this is bound to have two undesirable effects. First of all, it will inspire hundreds of youngsters with the ambition to be aerial stunt-artists; and, secondly, it will hasten the day when conservative citizens like myself, who began by admiring Colonel Lindbergh, will involuntarily be turned against this young man as a result of the superabundance of publicity the editorial fraternity is thrusting upon him."—M. P. W., Ithaca, N. Y.

Not Sighted Yet

"WAS turning over some of my back numbers of POPULAR SCIENCE MONTHLY when I came upon the article about the sixty-hour transatlantic speed boat in the April, 1928, issue. This article said that Adrien Remy, French inventor, was putting the finishing touches on the new craft, which consisted of two large pontoons between which the cabin, motor, etc., were suspended, and that he planned soon to start for New York.

"I was just wondering why it hasn't arrived yet."—C. H. B., Brooklyn, N. Y.

And More Coming

"I WANT to congratulate POPULAR SCIENCE MONTHLY on some of its recent articles which have been extremely interesting. As a reader who, like J. P. F., of Chicago, does not go in much for aviation news, I have been especially pleased by the features on other subjects. The article on plant pills was particularly good, and I hope P. S. M. intends to keep in touch with further developments of that sort and let its readers know about them.

"E. E. Free's articles, one in the October and one in the November issue, on 'Everyday Wonders in Colloid Chemistry' and 'Rays—the Clue to Evolution' respectively, were fine. I hope that Dr. Free will continue to help readers like me to keep up with some of the broader phases of science. And even if I don't read much aviation stuff, I must say that the Zeppelin and Lindbergh articles in the October number were humdingers."—A. W. K., Arlington, Mass.

After You, Professor

"I SEE by POPULAR SCIENCE that Professor Goddard is going to catch sunbeams and make them run everything on a farm from tractors to washing machines. It's a great idea—there's real farm relief for you! Now what the professor and Einstein ought to figure out together is how to put the cows on wheels and the chickens on trolley wires. Pipe lines for milk and endless belts to bring eggs from the henhouses might help, too.

"Perhaps I'm a back number. But I guess I'll just keep running my wasteful, inefficient farm in about the same old-fashioned way I always have. I don't think I'll scrap my gasoline lighting plant and my backfiring tractors just yet. It's all very well for a college professor to tell us how to make sunbeams work for us. But my suggestion to him is to get himself a farm and try it out himself first."—G. H. B., Centerville, O.

One of the Sciences

"S. F., of Madison, N. J., writes as his argument against aviation articles the fact that articles on physics, geometry, and other sciences of that type should be published more than those about aviation. That is all very well, as they make fine reading, but I don't think that aviation should be made the 'goat' for them. Aviation is as much a science as any of the others and should be dealt with accordingly.

"As S. F. said, there are strictly air magazines for people of my type who like aviation and are air-minded enough to see its future. As a counter stroke I say that more articles about aviation in magazines of *all* types will help speed its progress.

"It will not be many years until the nation with the largest commercial air transport system will be the leader, just as it was on the seas in olden times. The others will just follow and take what's left. Although I don't want to prepare for war, the nation filled with more privately owned planes will also have the greatest war strength, because it takes but a short while to turn a good civilian plane into a fighter.

"In closing—let's have more aviation articles and boost that field of science sky high."—R. D. P., Fairbury, Ill.

Stuck!

"E. E. FREE'S article on colloid chemistry told how colloids help us shave, cause cataracts on the eyes, and make postage stamps stick. The part about rouge sticking to a flapper's lips with a pressure of 200,000 pounds to the square inch raised an argument in our family. At a movie the other night the heroine kissed the hero and left rouge marks on his cheek. What we want to know is, if it takes a pull of 200,000 pounds to the square inch to pull off rouge, why this didn't hurt. My daughter thinks it did, but that they were enjoying themselves too much to notice."—E. D. R., Reno, Nev.

The Old "Grey Wolf"

"WE ARE very much interested in the automobile story 'Scorching in My Horseless Carriage,' and in the pictorial section, 'Tracing Your Car's Family Tree.' There are so very few men who remember the old days of the automobile, new as the industry is, that perhaps one writing on the subject might be pardoned for overlooking many interesting facts.

"The story talked about high speeds of

COOLS *while you shave and the coolness lingers! Listerine Shaving Cream.*

"*The same advice I gave your Dad*... **LISTERINE**, *often*"

Do you remember—

When the good old family doctor came into the house how your heart began to thump? You didn't know but what you had cholera morbus or something equally dreadful. You saw yourself dying in no time.

Then his firm, gentle hands poked you here and there. His bright, kind eyes looked down your gullet. And, oh, what a load left your mind when you learned that your trouble was only a badly inflamed throat and that Listerine would take care of it!

The basic things of life seldom change: Listerine, today, is the same tireless enemy of sore throat and colds that it was half a century ago.

It is regularly prescribed by the bright, busy young physicians of this day, just as it was by those old-timers—bless their souls—who mixed friendship and wisdom with their medicines.

Used full strength, Listerine kills, in 15 seconds, even the virulent Staphylococcus Aureus (pus) and Bacillus Typhosus (typhoid) germs in counts ranging to 200,000,000. We could not make this statement unless we were prepared to prove it to the entire satisfaction of the medical profession and the U. S. Government. Three well-known bacteriological laboratories have demonstrated this amazing germ-killing power of Listerine. Yet it is so safe it may be used full strength in any body cavity.

Make a habit of gargling systematically with full-strength Listerine during nasty weather. It aids in preventing the outbreak of colds and sore throat. And often remedies them when they have developed. Lambert Pharmacal Company, St. Louis, Mo., U. S. A.

Gargle with full-strength Listerine every day. It inhibits the development of sore throat, and checks it, should it develop.

How to prevent a cold
Rinsing the hands with Listerine before every meal destroys the germs that lodge there.

It checks* SORE THROAT *quickly

KILLS 200,000,000 GERMS IN 15 SECONDS

thirty miles an hour at a time when the Packard four-cylinder car was being built. It might interest you to know that this four-cylinder car followed the Packard Grey Wolf, which was the first car to make a speed of a mile a minute. Incidentally, this car had a spiral beveled gear in the rear axle, which really was the thing that made possible abandonment of chain drives about which your story deals."—H. F. O., Packard Motor Car Company, Detroit, Mich.

? ? ? ? !

"I'M NOT going to answer S.K.'s question 'Where did the lost flying hours go?' in the way that he expects. Instead I'm going to ask him a question. How many different combinations of numbers did he try? Here are two he missed.

"Suppose the speed of the plane to be fifty miles an hour and the velocity of the wind fifty. With the wind, according to S.K.'s reckoning, the plane will go 100 miles an hour and take three hours to cover a 300-mile journey. Now when the plane starts back, if one accepts his reckoning, its speed is no miles an hour. In other words it stands still.

"Suppose the figures to be fifty miles an hour for the plane and 100 for the wind. How long will it take for the machine trying to 'buck' the wind to reach a place of the same latitude 300 miles away? Assume the circumference of the earth at our plane's latitude to be 24,000 miles, then the correct answer is 474 urs—and it will arrive tail first! Figure it ut."—M. P. R., Columbus, O.

"Simple Arithmetic"

THE mysterious loss of two hours in S.K.'s flight from Los Angeles to San Francisco and return is accounted for quite easily. The plane travels at 100 miles an hour. The distance is 300 miles. The air velocity is fifty miles an hour. The plane therefore makes the trip with the wind in two hours and against the wind in six hours. This is simple arithmetic. The total flying time is eight hours as compared with the six hours which would quite obviously be required for the trip if there were no wind. The difference is two hours. More simple arithmetic!

"The plane is in the air a total of eight hours, during which time it is carried by the wind a total of 200 miles. The plane's speed is 100 miles an hour, so that it has to travel the extra two hours to make up for the distance it is carried by the wind. Still more simple arithmetic!"—N. K., Baltimore, Md.

From Bald-Headed Row

"THREE cheers for page 55 of your October number! The comely faces of our flying gals certainly came as a welcome relief from the surfeit of portraits of gadgets and their sober-visaged inventors you have been giving us since I became one of your readers.

"Far be it from me to wish that Popular Science Monthly should turn frivolous in its old age, but, after all, even the scientifically and mechanically minded are only human and none of us enjoys a case of eyestrain. Please repeat."—B. A. S., Chicago, Ill.

Changed His Mind

"I THOUGHT I would discontinue taking the magazine, but each number was more interesting than its predecessor."—A. K., Ludington, Mich.

Who'll Help Him Out?

"MY SON reads your magazine faithfully, but I am sick of having it around the house. Every month you get all heated up because somebody has invented something. What of it? Have the inventions we have now made men any wiser or more intelligent? Do they inspire any greater thoughts? Not a bit of it! When the phonograph was invented, the first words spoken into it were: 'Mary had a little lamb.' When the telephone was invented, the first words spoken through it were: 'Come here, Watson.' And to inaugurate the transatlantic telephone, the Mayor of New York said to the Mayor of London: 'How's the weather over there?'

"Why get excited because radio travels around the world when it usually carries something like 'I Faw Down and Go Boom'? Why have catfits over the talkies when they are used to let us hear the splash of the custard pie that hits the comedian's face? Why rave over the wonders of the electric light when it keeps people running around at night when they ought to be in bed?

"If any reader of your magazine can point out one single thing this flood of inventions has done to elevate man's mind or make him happier, I wish he would do it.—M. O. R., New York, N. Y.

A Cure for Loneliness

"BEING a regular reader of your very interesting magazine, and having built the *Sovereign of the Seas*, *Constitution*, and the *Santa Maria* from your articles by Captain McCann, and having won several prizes with same, I am inclosing your coupon with blueprints marked for the pirate ship, the Spanish galleon, and the *Mayflower*.

"As an old English apprentice serving my time in sailing ships out of Greenock, Scotland, I take great pleasure in making these models, and I have pleasant memories when I read Captain McCann's explanation of different parts of the vessels such as lubber holes, clews, sheets, and buntlines. It will no doubt be a great pleasure for Captain McCann to know that, as I am now stone deaf, he has the means of giving me unlimited pleasure and happiness in building these models and so keep my mind off my affliction. It surely takes the loneliness out of my evenings, and I am wondering if I may make the suggestion that he will some time give us a model to make and put in a bottle, as we used to do on the old skysail yarders."—G. C., Rapid City, Manitoba, Can.

In a Nutshell

"I SUBSCRIBED to Popular Science Monthly as an experiment. Now I feel that it is one of the most interesting magazines published and that I cannot get along happily without it."—M. L. A., Gloucester, Mass.

"Popular Science Monthly is the best magazine dealing in mechanics and kindred subjects I have ever had the pleasure of reading."—W. C. W., Hornsby, Ill.

"Your magazine is in line with my work and I enjoy reading it. I am building a new motor and will tell you about it when it is finished."—W. C. M., Donnelsville, O.

"Wish Popular Science came every week. Cannot be without it."—G. C. S., Taft, Calif.

"I agree with S. F., of Madison, N. J., that Popular Science Monthly should print more chemistry, physics, and geometry, but I do not wish for any of the aviation news to be abolished."—J. D. McPh., Birmingham, Ala.

"Popular Science Monthly is fascinating in all its departments. I especially enjoyed Mr. Keyhoe's article with the wonderful pictures of 'Lindy'."—Mrs. A. M. G. T., Philadelphia, Pennsylvania.

"I think your magazine is great. I have been reading it for several years and cannot find better scientific reading matter. Keep up the Home Workshop and radio sections."—L. L., Richmond Hill, N. Y.

"I would like to take this opportunity of complimenting you upon the wonderful make-up of your journal and to say that it has afforded me many hours of interesting and educational reading. I believe it has no competitor in its particular field. You are to be congratulated."—J. C. H., Los Angeles, Calif.

A Helpful Habit

"I HAVE a habit. It's a peculiar one, but very helpful at times. Often it is necessary, or at least desirable, to hold a flashlight so that it will shine wherever you need it, and still have both hands to work with. This can be easily accomplished by holding the light between the arm and the body just below the armpit, and gives surprising freedom in the use of the arm."—R. B. H., Vicksburg, Mich.

Scrap the Submarines?

"YOUR articles dealing with submarine disasters have interested me greatly. I think that some of the safety devices you described were really ingenious, but if the submarine is sunk in really deep water all attempts at rescue are useless. The tragic sinking of our own *H-47* brings this fact to light. She was sunk in sixty fathoms and after a brief attempt all salvage operations were abandoned. The loss was fourteen young men.

"These terrible disasters have aroused a storm of protest over here and the general idea is to scrap subs. What do your readers think of it?"—G. N. G., London, England.

The Retort Courteous

"IS MRS. D. B. J. on your November 'readers' page trying to be funny? Or is she just old-fashioned? For many men who are troubled with bad dreams the words 'sin' and 'conscience' have long ceased to have any meaning. If Mrs. D. B. J. really wants to know, I hope she will take a bachelor's word for it: the cause of this misfortune is probably that too many men have wives like her whose nagging haunts even their husbands' sleep."—R. H. D., Olean, N. Y.

From the Sick Room

"FOR anyone who is confined in bed as an invalid, Popular Science Monthly is a life-saver. It is one of the few magazines that gives a person something worth while to think about when he has nothing to do but lie still and think. I enjoy every page of it."—F. S., Monrovia, California.

Worth Preserving

"MAY I compliment you upon your rotogravure section. When you added the feature I thought it would be just another jumble of freak pictures. Instead you have made something fine of it. Your recent picture presentation of Edison's career, the development of the airplane, and Lindbergh's life are features which I am sure will be preserved in many American homes for years to come."—R. U., Pittsburgh, Pa.

>> ON DUTY WITH THE NEW YORK STATE POLICE <<

FROM THE CANADIAN BORDER TO LONG ISLAND SOUND, PATROL CARS CARRY THIS UNFAILING WINTER PROTECTION » » EVEREADY PRESTONE

Eveready Prestone does not contain any alcohol or glycerine

READ what Major John A. Warner, Superintendent, has to say about the use of Eveready Prestone, the perfect anti-freeze, in the cars used by the New York State Troopers in the performance of their duties:

"We are glad to inform you that our experience this winter in using Eveready Prestone in the cars operated by the New York State Police has again been a happy one.

"This present winter is the second during which the anti-freeze has been used, and thus far we have had no single instance where complaint has been found with it. It has been employed with different makes of cars, and under the most trying of weather conditions. In the performance of their duties, our men range from the Canadian border through the Adirondacks down to the southern parts of the State. Frequently they are on the open roads for hours at a time, during which their cars must function under all sorts of stress and strain.

"It is gratifying to us that during the past two years Eveready Prestone has contributed so materially to the success with which the State Police have been able to carry on their work."

Whenever men, engaged in hazardous cold-weather duties, entrust their lives and reputations to motors, there you will find Eveready Prestone. At Army flying fields. At Navy air stations. With Commander Byrd in the Antarctic. And one supply of Eveready Prestone will provide *your* motor with the same permanent protection against freezing. It possesses *all* the properties pointed out by the National Bureau of Standards as essential for an anti-freeze.

9 POINTS OF SUPERIORITY

1. Gives complete protection.
2. Does not boil off.
3. Positively will not damage cooling system.
4. Will not heat up a motor.
5. Circulates freely at the lowest operating temperatures.
6. Will not affect paint, varnish or lacquer finishes.
7. Non-inflammable.
8. Odorless.
9. Economical—one filling lasts all winter.

Thoroughly tested and 100% approved by the American Automobile Association

EVEREADY PRESTONE

(TRADE-MARK REG.)

FOR PREPARATION OF THE

PERFECT ANTI-FREEZE

Once the cooling system of a car has been flushed out and tightened, a single supply added to the radiator will provide trouble-free surety against all freezing hazards through all kinds of weather.

It is time *now* to have Eveready Prestone in your car. You can buy it at the nearest garage, filling station, automobile supply shop or hardware store.

NATIONAL CARBON CO., INC.
General Offices: New York, N. Y.
Branches: Chicago Kansas City
New York San Francisco
Unit of Union Carbide UCC *and Carbon Corporation*

NOISE upsets your entire organization

. . . hampers the clear thinking of your executives

. . . encourages the errors of your subordinates

LISTEN to the steady succession of noises in the average office. Just hear the clatter of typewriters, clamor of telephones, slamming of doors, the constant rise and fall of voices.

This disturbance places a handicap upon your entire organization.

For all these noises echo and re-echo from the ceiling . . . making a nerve-wracking undercurrent of sound that cuts into concentration and destroys a share of each man's value.

None of the people you pay to think ever gets used to NOISE. And in a year's time it writes a big entry on the debit side of your ledger.

So progressive business men are putting an end to unnecessary noise with Acousti-Celotex, the noise-absorbing fibre tile, applied to their ceilings. The list of companies who are eliminating costly errors and speeding up office efficiency with Acousti-Celotex is filled with familiar names.

Acousti-Celotex has clearly proved its value in hundreds of these installations. It can be quickly and easily installed in new or old buildings. It comes in rigid, finished units easy to keep clean, and can be painted even with lead and oil paints without losing its sound-absorbing efficiency.

Architects are using Acousti-Celotex in hospitals to provide restful quiet—in schools and colleges to insure less noise and better hearing—in churches to eliminate echoes and reverberating sounds—in moving picture theatres to improve the presentation of sound-pictures.

Mail the coupon below for our interesting booklet, "Acousti-Celotex versus Noise;" with complete information about this remarkable material, showing in detail how Acousti-Celotex subdues NOISE in all types of buildings.

The Celotex Company, Chicago, Illinois. In Canada: Alexander Murray & Co., Ltd., Montreal. Sales Distributors—everywhere. Acousti-Celotex is sold and installed by Approved Acousti-Celotex Contractors.

The word
CELOTEX
(Reg. U. S. Pat. Off.)
is the trademark of and indicates
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The Celotex Company
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ACOUSTI—CELOTEX

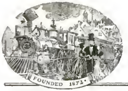
FOR LESS NOISE—BETTER HEARING

THE CELOTEX COMPANY Pop. Sci 12-29
919 North Michigan Avenue, Chicago, Illinois
Please send me your interesting free Booklet—"Acousti-Celotex versus Noise."

Name ....

Address ....

City .... *State* ....



Popular Science MONTHLY

DECEMBER, 1929 TRAVIS HOKE *Editor* VOL. 115, NO. 6

A New World Run by Dynamo

For months, now, political and industrial leaders and the newspapers have been talking excitedly about "power" and "super-power." Seldom, however, has anyone explained exactly how or why the discussion is a matter of public concern. This article tells in simple terms why every family and every factory has a vital interest in future sources of electric power, which already has entered 19,000,000 homes, has given to every factory worker the equivalent of 55 helpers, and serves three fifths of the American people.

By GROVER C. MUELLER

"THE North Pole could be made into a summer resort if sufficient power were available." So declared the Earl of Birkenhead, who is one of England's greatest statesmen and a leading figure in the electric power industry, on a recent visit to the United States.

That would be a fanciful project. The largest electric dynamo in the world, a turbogenerator of 165,000-kilowatt capacity recently installed, together with another of equal size, at Hell Gate power station in New York City, would be doing well to turn 300 acres of that vast frigid region into a garden spot. But what electric power is doing right at home, in the United States, is fully as startling and far more practical.

The fact is that the world is face to face with a second industrial revolution. One hundred years ago the first industrial revolution, which Watt started with his invention of the steam engine, was well on its way to transforming the world. Factories and mass production followed in its wake. A worker who laboriously fashioned a few nails from wire daily by hand now stood at the levers of a machine that made them by the thousand.

The second revolution promises to eclipse the first. Electricity has brought it about. Installation of boilers and steam engines in factories is virtually at a standstill. Not everyone knows that the power situation has so changed that more than three fourths of America's industry is electrified. "Power" means "electricity" today.

The Dynamo Era is here. It is symbolized by gaunt pinnacles of high tension towers that dot the countryside. Power as fluid as water flows along metal strands from distant power house to factory. The mere snapping of a switch puts its brute force to work. It is strong enough to forge glowing steel ingots into rails and wires. Because it is not bulky, as coal is, it can be shot over thin wires to industrial plants far from cities, even to manufacturing plants located in remote and inaccessible places. It is clean. And it is so economical that it is setting new styles in mass production.

Niagara's thunder is reflected in the roar of the 70,000-horsepower turbines that harness the waterfall and send its power flashing over high tension wires.

Industry is not alone in benefiting by the revolution that brings electric power. Electricity has entered nearly 19,000,000 homes. It serves three fifths of the American people. It heats 17,000,000 flatirons, runs 7,700,000 vacuum cleaners, and operates 5,700,000 washing machines. It fills more than a million ice chests, and cooks in 725,000 stoves. A dollar's worth of electricity before the war costs only eighty-two cents now, according to Paul S. Clapp, of the National Electric Light Association—though living expenses, instead of falling, have risen sixty-five percent.

WHAT is ahead? The late Charles P. Steinmetz, electrical engineering genius, predicted that electricity, by doing most of the world's work, would release everyone to almost boundless leisure. Super-power, the mass production of electricity by a few central stations in the United States, may bring it about. It is the dream of engineers, and the next logical step in the new revolution.

One of the two largest generators of electric power in the world, which was recently installed at the Hell Gate power station in New York City. It is a turbine generator of 165,000 kilowatt capacity.

When cheaper and more abundant power comes, a factory worker will perhaps toil but two or three hours a day. Electric machines will enable him to accomplish in that time what it takes a present-day workman a full day to perform. In the home, the revolution will be as complete. Cooking with electricity will be the custom, instead of a luxury. Homes will be heated by electricity. Other uses will be found which no one today can possibly imagine.

SUPER-POWER, as conceived by engineers, means hooking up all power plants into one vast web that would span the whole country. Perhaps there would be no more than a hundred power houses in all—giant factories of power that would eclipse any in existence today. California and Pennsylvania would exchange power. Because of differences in time across the continent, one section of the United States could help to supply the nighttime demand of another. When night approached in New York, Chicago's power houses would help to light the gleaming lamps of the "Great White Way." As darkness spread to the Middle West, Colorado and Nevada and other far western states would switch in their dynamos to help shoulder the burden of lighting the states to the east. Almost by the time the West grew dark and commenced to turn on its lights the East would have turned them off and gone to bed.

Moreover, when a drought cut down the power of Niagara Falls, New York with its coal-burning stations could make up the difference. When water was plentiful the coal stations would shut down and let the hydroelectric power houses carry the load. Thus the super-power web would be a sort of "clearing house" for electric power.

Engineers have gone far toward carrying out this bold scheme, despite the great technical difficulties of hooking up power lines serving different sections. Already there is a 1,000-mile triangle of super-power wires connecting Chicago, Boston, and Pensacola, Fla. In a recent test Chicago's power houses successfully ran the city of Boston. There is a continuous power supply chain along the Pacific Coast from Canada to Mexico. Wisconsin and Michigan are tied up in a mid-western hook-up. Today fully one tenth of all the electricity generated in the United States is used in another state from that which produces it.

A DOLLAR'S worth of electricity before the war now costs only eighty-two cents. In America electricity heats 17,000,000 flatirons, runs 7,700,000 vacuum cleaners and 5,700,000 washing machines, and fills more than a million ice chests.

Super-power's value received a striking demonstration in the floods that swept New England and the Mississippi region two years ago. Individual power plants in the flooded areas were destroyed. But the electric power went on.

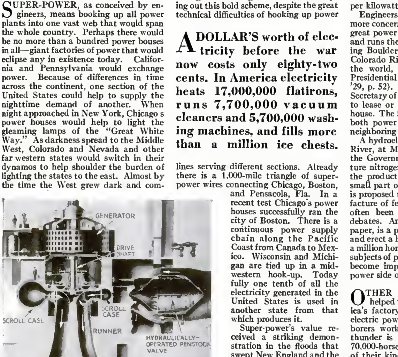


Diagram of one of the 70,000-horsepower turbines at Niagara Falls. A locomotive could run through its penstock, at the right.

Faced with this mass production of electricity, industrial leaders realize that electric power is a commodity, just as tangible and desirable as petroleum or coal. So great a banking firm as J. P. Morgan and Company is now interested in obtaining power sites. Various political fights have occurred over the question whether power plants should be run by individual private companies, as they are today to a large extent, or by the federal, state, or municipal governments.

AGAINST the economy of operation by experienced firms, some observers urge the nonmonopolistic safety of public control. There are variations of each of the two schemes, of which a novel one operates with unusual success in Ontario, Canada. This province's power is owned and operated by the government's Hydroelectric Commission, which delivers it under contract to municipalities. The power rate is high, but the domestic rate is so cheap that farmers use it even for cooking. Monthly bills in Woodstock, a town of only 10,000 population, have averaged $4.96 for families who were lighting and cooking by electricity. In most cases rates are as low as 1.9 cents per kilowatt hour.

Engineers and scientists, however, are more concerned with the realization of great power projects than with who owns and runs them. The project of constructing Boulder Dam, which will block the Colorado River with the greatest dam in the world, recently was confirmed by Presidential proclamation (P. S. M., Nov. '29, p. 52). Congress has left it with the Secretary of the Interior to decide whether to lease or operate the dam and power house. The 525-foot-high dam will supply both power and water for irrigation to neighboring states.

A hydroelectric plant on the Tennessee River, at Muscle Shoals, was erected by the Government during the war to capture nitrogen from the air and use it for the production of explosives. Today a small part of its power is in use, while it is proposed to use the rest for the manufacture of fertilizer—a subject which has often been discussed in Congressional debates. Another project, at present on paper, is a plan to dam the St. Lawrence and erect a hydroelectric plant of perhaps a million horsepower. All of these familiar subjects of political controversy may soon become important factors in the super-power side of the electric revolution.

OTHER great power projects have helped to give three fourths of America's factory workers the equivalent, in electric power, of a gang of fifty-five laborers working under each. Niagara's thunder is reflected in the roar of the 70,000-horsepower turbines, the largest of their kind in the world, that harness the waterfall and send its power flashing over high tension wires. Two 165,000-kilowatt steam-driven generators, biggest electrical machines of all, have just been added to the mighty Hell

Gate plant in New York City, whose twenty-four boilers all but scrape a ceiling 100 feet high. A million-horsepower plant rising near by, to be completed in 1930, will pump a torrent of water from the East River twice as great as the Catskill aqueduct carries to New York, to cool its turbines' steam. A 208,000-kilowatt generator which will create electricity at 18,000 volts is soon to begin operation in Chicago. With the power of more than 270,000 horses, it will be the most titanic electric machine in existence. These will be parts of the electric network that feeds America's homes and factories eighty-eight billion kilowatt-hours of electricity yearly.

THERE are still untold reserves of power to draw upon. America has harnessed only one fourth of the total water power it has available, according to the United States Department of the Interior. How much power may be added by burning coal nobody knows. Should the coal be exhausted, there would still remain the hope of additional power in harnessing sunlight, wave power, or the tides. Of course those are for the future.

Today there are just two important ways to get electricity. Wherever coal is available to be burned under a boiler, electricity can be generated by steam power. Wherever water flows in a river it is possible to build a dam, raise the level of the water, and let it flow down through a turbine. If there is already a natural drop in the river, such as that at Niagara Falls, it saves the trouble of building a dam. Today two thirds of the Nation's electricity is generated by steam and one third by water power.

Because coal costs money and water runs downhill for nothing, many persons imagine that water power is always cheap power. But that is not always so. The cost of constructing and maintaining plant and transmission line, the interest on investment, and losses in transmission must all be paid for by the power user.

Another reason water power does not always mean cheap power is that it fluctuates from one season to another. The $50,000,000 machinery of Muscle Shoals is engineered to be capable of producing 610,000 horsepower. When the river is low only 100,000 horsepower is available.

The public wants current when it wants it and not in a smooth, steady stream day and night as the company would prefer. That is why, for instance, New York City has an automatic storm detector at one of its main generating plants. Should a thunderstorm darken the sky, millions of persons will turn on electric lights. Everyone will demand current at once. Therefore the mechanical storm prophet flashes a warning to the power plants of the city, and the results are as exciting as a fire alarm. Klaxons scream above the deafening roar of the turbine rooms. Coal cars leap into swifter action to fill the bunkers that supply the mighty boilers. Under the generalship of operators at the power plant's control board, which is ornamented with switches and flashing lights, fans speed up to force air into the boilers. Soon the steam pressure rises, ready to help the mighty turbines fight the added load of the storm.

MORE than three fourths of America's industry is electrified. When cheaper and more abundant power comes, workers may perform, in two or three hours, work that now requires a full day.

Courtesy, The Digest

Penstocks and power houses of a new hydroelectric power project at Sao Paulo, Brazil. Waters from a mountain river fall approximately 2,000 feet to drive the blades of turbine generators.

One hundred thousand horsepower is the capacity of this power house at Wilson Dam, one of the units of the huge Muscle Shoals development. The capacity of the entire project is 610,000 horsepower.

Even an eclipse of the sun calls a power plant into sudden action. Astronomers had warned New York power plants that the moon's shadow would darken half the city during the solar eclipse of 1925, and they were ready. At eight o'clock in the morning the sun's disk commenced to be obscured. Power officials noticed that more electric lights than usual were going on, judging by the load the electric dials indicated, as the moon's black disk obscured the sun. Suddenly the dials shot up. The eclipse was total. Almost simultaneously word flashed from the power houses that New York was draining them of 424,000 kilowatts instead of the usual 348,000 at that hour. The sudden increase of 76,000 kilowatts was almost without precedent, but the power plants managed to supply it and New Yorkers had light when they wanted it. But they were careless beneficiaries of the plans made for them! The power records showed that many, particularly in office buildings, forgot to turn the lights out again after the eclipse, and the demand for electric current was more than normal all day.

VITALLY as these power plants are interested in supplying electricity for light, it is only one of the important uses today. The history of the industrial revolution that brought it into factories for power commences in the eighties when an innovation appeared—the electric street car. It was the first great application of electricity on a large scale. And, coupled with im-

(Continued on page 132)

First Victories in the War on Fog

Research station and radio transmission towers of the Massachusetts Institute of Technology at South Dartmouth, Mass., where experts are studying methods of overcoming the menace of blinding fog.

FOG costs the world millions of dollars a year in transportation delays and accidents. It is the arch foe of flyers and mariners. A bucket of water in the form of fog can tie up the port of New York or London, and can send airplane pilots to their death. This article describes important gains in the first large-scale attempt of science to conquer the worst of man's weather enemies.

By

EDWIN W. TEALE

FLYING "blind," in an airplane cockpit so covered by a hood that he could see only the glowing dials of the instrument board, Lieut. James Doolittle, a crack Army pilot, took off at Mitchel Field, New York, the other day, flew seventeen miles, returned to his starting point, and made a perfect landing. Airmen hailed his feat as an important advance in the efforts of science to conquer the greatest menace of flying—fog.

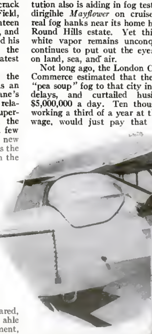
Three new instruments made the "blind landing" possible. One was an "artificial horizon" showing the plane's lateral and longitudinal position in relation to the earth. Another was a supersensitive altimeter which recorded the height of the machine to within a few feet of the ground; a third was a new radio direction-finding apparatus. As the machine flew, two metal "reeds" on the instrument board were operated by waves sent from a radio beacon at the flying field. They guided the pilot on a straight line. If the plane swung to the right of a direct line to the field, the right reed oscillated violently, and vice versa. When the plane passed above the sending station, the signals momentarily stopped. This indicated to the flyer that he was above his landing place and he nosed the machine down, judging its height above the ground by the altimeter.

In dense fogs, Lieut. Doolittle declared, air mail and transport pilots will be able to land by use of the new equipment, which is the result of eleven months of experiment in fog flying under the direction of the Guggenheim Fund for the Promotion of Aeronautics.

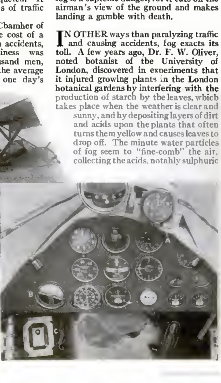
This is just one of the recent developments in science's war upon the white enemy. On the Round Hills estate of Col. E. H. R. Green, at South Dartmouth, Mass., a unique "fog laboratory" has been established by the Massachusetts Institute of Technology for creating and studying artificial mist. The same institution also is aiding in fog tests with the dirigible *Mayflower* on cruises through real fog banks near its home base on the Round Hills estate. Yet this blinding white vapor remains unconquered. It continues to put out the eyes of traffic on land, sea, and air.

Not long ago, the London Chamber of Commerce estimated that the cost of a "pea soup" fog to that city in accidents, delays, and curtailed business was $5,000,000 a day. Ten thousand men, working a third of a year at the average wage, would just pay that one day's damage bill. A "London particular" once settled over the Estuary of the Thames and lasted for five days. No vessels could move. The estimated loss to shipping alone was a million dollars a day. In May, 1928, a cloud of mist that remained for forty-eight hours tied up traffic in New York harbor. Eight ocean liners collided. To swift-moving airplanes fog is a supreme danger, for it cuts off the airman's view of the ground and makes landing a gamble with death.

IN OTHER ways than paralyzing traffic and causing accidents, fog exacts its toll. A few years ago, Dr. F. W. Oliver, noted botanist of the University of London, discovered in experiments that it injured growing plants in the London botanical gardens by interfering with the production of starch by the leaves, which takes place when the weather is clear and sunny, and by depositing layers of dirt and acids upon the plants that often turns them yellow and causes leaves to drop off. The minute water particles of fog seem to "fine-comb" the air, collecting the acids, notably sulphuric



Hooded airplane cockpit in which Lieut. James Doolittle, Army pilot, completed his remarkable "blind" flight of 17 miles.



Instrument board of Lieut. Doolittle's plane, showing "blind" flying aids—a special altimeter (A), "artificial horizon" (B), and new radio direction finder (C).

acid, which are given off by coal fires. These acids not only injure plants but eat into stone buildings. Experts of the British government now are conducting experiments to prevent the erosion of buildings by the action of fog.

One of the unusual ways in which fog causes damage is reported by a Long Island radio broadcasting station. Several times in midwinter dense fog banks, rolling in from the Atlantic, have enveloped the antennas. The moisture, freezing to the wires, has weighed them down until they have snapped, interrupting programs. To relieve the strain on the wires in such emergencies, the antennas are now equipped with counterweights, like those in a window sash, which rise as the weight of the wires increases.

OCCASIONALLY, fog proves a friend of man instead of an enemy. Once, it helped put out a forest fire that was eating its way through valuable forests in the state of Washington. During rainless summers in southern sections of the Pacific Coast, fog prevents excessive aridity that would ruin vegetation. In a single night, such a fog has been known to deposit as much as five hundredths of an inch of water, the equivalent of a moderate shower. On the coast of Peru, where there is little rain, plants grow luxuriously during several months of the year, watered only by the drizzly fog of the region.

A fog is essentially a cloud that is close to or touching the earth. When water vapor is condensed by chilling and made visible near the earth, it is called a fog. When the operation is carried on overhead it is called a cloud. Clouds and fogs both consist of tiny drops of water condensed around some sort of nuclei, usually dust particles. They are made up of baby raindrops that never grow up. These are so small that they cannot fall against the friction of the air, or if they do fall, they descend very slowly.

Often these water particles are only one twenty-five thousandth of an inch in diameter. In a dense sea fog there may be more than ten thousand of the pin-point droplets in one cubic inch. The density of the fog depends upon the number and size of the water particles.

WHAT stunts the growth of these baby raindrops? Why do they not combine into larger drops and fall as rain? A plausible theory is that minute electrical charges on each push them apart. Similar charges of electricity, either negative or positive, would repel the fog particles from each other and arrange them at about equal distances in space.

When a warm, moist current of air meets a cold current and the moisture condenses into drops almost as small as molecules, fog is born. The famous fogs of the Banks of Newfoundland are created by the meeting of the cold air over the Labrador Current from the north and the warm, moist air above the Gulf Stream from the south. These fogs are so dense that one of the sea yarns of the old New England whalers told of jib booms that had been broken by bumping into a Newfoundland fog.

A billowy sea of fog off the California coast, photographed from above by F. Ellerman. Fog is essentially a cloud that is close to or touching the earth, and is made up of countless tiny water particles.

Fog also is created through radiation of heat. During the night the air loses heat, and if it happens to be quite humid so that the air contains a lot of water, the moisture condenses on the dust particles in the air to form fog. The same thing happens when a body of cold air comes in contact with a body of warm, moist air.

One of the surprising things about fog blankets is that they contain so little water. A cubic mile holds scarcely a gallon. A bucket of water in the form of fog could tie up the port of New York or London and cost thousands of dollars.

Were it not for the wind-borne particles of dust and soot in the air, there would be little, if any, fog. One of the causes of London's celebrated "pea soup" is the soot that hangs in the air, produced from the seventeen million tons of coal the inhabitants burn each year. In a London street, experts estimate, a man inhales two billion particles of soot in ten hours. Over New York City, more than 2,000 tons of dust hangs in the air, Professor H. H. Sheldon, of New York University, recently announced after making a series of measurements.

IF COAL fires were supplanted by some other method of heating that did not discharge unburned particles of carbon into the air, large cities would be freer of fog than the surrounding country. The heat rising from the many buildings would evaporate the moisture.

Tests have shown that the rays from glowing neon lights are more effective than ordinary white light for penetrating smoke-created fogs, in which the nuclei of the water droplets are largely floating bits of soot. For white "country fog", in which the nuclei are particles of dust—bits of fibers, vegetable matter, and molds—white light is said to be just as effective in piercing the fog.

The neon light, first produced by the French physicist, Georges Claude, in 1910 by passing an electric current through a glass tube filled with neon gas, is of especial value in guiding flyers through city fogs to invisible airports. It is one of several recent inventions which are helping prevent accidents in fog. Another is the radio beacon. It provides a path or beam of radio signals which an airplane pilot can follow by the intensity with which they are received. In the ordinary beacon, as soon as a flyer veers from the path, signals fade out. Experimental altimeters (Continued on page 158)

"London Fog," a prize photograph by Dr. Maximilian Toch, F.R.P.S., showing the Thames and Houses of Parliament enveloped in mist.

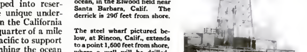
Oil Wells Drilled in the Ocean

Great Wharves of Steel Reach Out from California Shore to Tap New Deposits in the Bed of the Pacific

By GEORGE LEE DOWD, JR.

OIL from the bottom of the sea is now being pumped into reservoirs from three unique underwater oil fields on the California coast. Huge wharves, a quarter of a mile long, reach out into the Pacific to support the derricks used in plumbing the ocean bottom for petroleum. Within a distance of twenty-five miles, along the coast in the region of Santa Barbara, the operators of two new fields and an old one—the famous Summerland field—have invaded the sea in search of oil and rich new deposits have been found in the shale below the breaking surf.

The first oil well in the Pacific ocean, in the Elwood field near Santa Barbara, Calif. The derrick is 290 feet from shore.



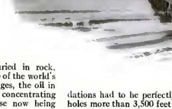
The steel wharf pictured below, at Rincon, Calif., extends to a point 1,600 feet from shore, where a well will be drilled.

Geologists long have known that the remains of fish, shellfish, and microscopic sea animals, buried in rock, have produced a large share of the world's petroleum. Through the ages, the oil in these sea deposits has been concentrating into pools similar to those now being tapped.

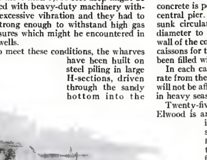
It was at Summerland, a few miles east of Santa Barbara, that the first drilling in the ocean was done in the United States. Since the railroad between Los Angeles and San Francisco skirts the beach at this point, this field is always pointed out to tourists as one of the sights of California.

The most extensive portion of the new marine development is located some twelve miles west of Santa Barbara and about a hundred miles from Los Angeles. In the surf paralleling the Elwood Terrace oil field, discovered a little more than a year ago, a dozen or more wharves are being built into the sea. Huge steel and concrete foundations for derricks are being constructed to make it possible to tap the treasure of the ocean floor. Building these wharves and foundations was an engineering problem of no mean proportions. They had to be made exceptionally heavy to withstand the shock of the hammering waves. The derrick foundations had to be perfectly rigid so that holes more than 3,500 feet deep might be drilled with heavy-duty machinery without excessive vibration and they had to be strong enough to withstand high gas pressures which might be encountered in the wells.

To meet these conditions, the wharves have been built on steel piling in large H-sections, driven through the sandy bottom into the shale underneath. They are reinforced with cross braces and all joints are electrically welded.



A view along the ocean bluff at the Elwood oil field, showing some of the wells on land, and the new wharves extending out from shore to derricks which tap the ocean bed.



At right: Sinking steel caissons at Elwood to form the supporting piers for the foundation of a derrick. The foundation must withstand the battering of Pacific storms.

Several types of construction have been employed in building the derrick foundations. One of these is a cofferdam structure, in which a concrete and steel island has been built around the area over which the derrick stands. Inside this a practically solid concrete block was set, founded on the shale bottom, and built to the height of the wharf floor, some twenty feet above the water. Another company has constructed foundations by driving fifteen-inch circular piling to form the outer wall of each of four corner foundations for the drilling rig, filling the center with reinforced concrete. These corner foundations are seven or eight feet in diameter. In the center, around the pipe through which the well will be drilled, a similar steel and concrete pillar has been built, but of fourteen feet diameter. The center pipe is thirty inches in diameter, and is driven into the shale as far as possible before the concrete is poured around it inside of the central pier. Still another company has sunk circular steel caissons ten feet in diameter to the shale to form the outer wall of the corner piers, and fourteen-foot caissons for the central piers. These have been filled with concrete.

In each case the foundations are separate from the wharf structure so that they will not be affected by warping or weaving in heavy seas.

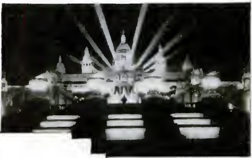
Twenty-five miles east and south of Elwood is another marine development, in some ways even more striking. Here, in the Rincon field, a steel wharf reaches into the ocean to a point 1,600 feet from shore. The wharf itself is 1,888 feet long, for the portion nearest the land, 764 feet in length, is placed at an angle of about forty-five degrees to the shore line.

The first well to be drilled in the water is to be at the end of the wharf, where a platform seventy-seven by 200 feet is being constructed to accommodate the derrick, machinery, and necessary tanks. It will be about half a mile from the nearest land well in the field, just above the high tide line.

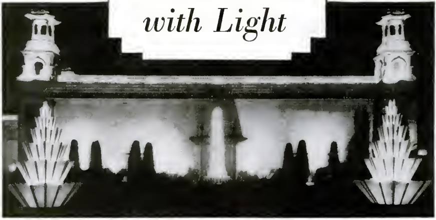
Painting a World's Fair with Light

Skillful lighting effects transformed buildings and grounds of the International Exposition at Barcelona, Spain, into a fairyland. Compare this daylight view of the beautiful National Palace with the nighttime photo reproduced at the right.

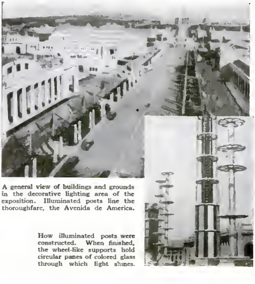
Courtesy Westinghouse Electric and Manufacturing Company



Even the sparkling cascades in front of the National Palace are illuminated. From caldron-shaped vessels in the background, rising steam is made brilliant with playing light beams of many different colors.

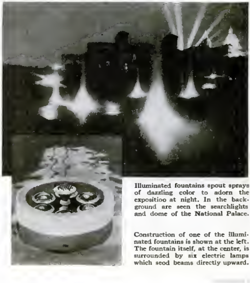


Powerful floodlights, bathing walls and towers, and ingenious indirect lighting effects, produced this artistic illumination of the royal palace, the Palacia de Alfonso XIII. A modern triumph made possible by fifty years of progress in lighting science.



A general view of buildings and grounds in the decorative lighting area of the exposition. Illuminated posts line the thoroughfare, the Avenida de America.

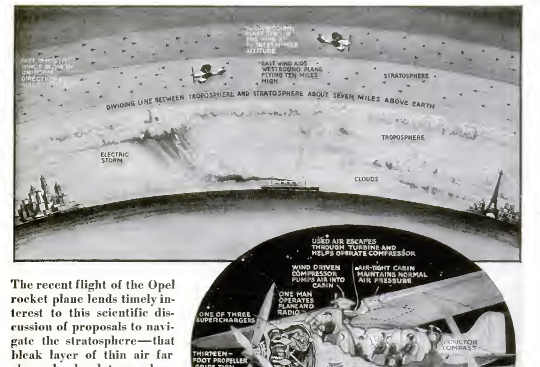
How illuminated posts were constructed. When finished, the wheel-like supports hold circular panes of colored glass through which light shines.



Illuminated fountains spout sprays of dazzling color to adorn the exposition at night. In the background are seen the searchlights and dome of the National Palace.

Construction of one of the illuminated fountains is shown at the left. The fountain itself, at the center, is surrounded by six electric lamps which send beams directly upward.

High Speed Skyways 14 Miles Up


EAST WIND AIDS WESTBOUND PLANE FLYING TEN MILES HIGH
STRATOSPHERE
DIVIDING LINE BETWEEN TROPOSPHERE AND STRATOSPHERE ABOUT SEVEN MILES ABOVE EARTH
TROPOSPHERE
ELECTRIC STORM
CLOUDS
USED AIR ESCAPES THROUGH TURBINE AND HELPS OPERATE COMPRESSOR
WIND DRIVEN COMPRESSOR PUMPS AIR INTO CABIN
AIR-TIGHT CABIN MAINTAINS NORMAL AIR PRESSURE
ONE MAN OPERATES PLANE AND RADIO
ONE OF THREE SUPERCHARGERS
INDUCTOR COMPASS
THIRTEEN-FOOT PROPELLER GRIPS THIN AIR
AT EXTREME ALTITUDES THE SKY IS BLACK AND THE STARS ARE VISIBLE IN DAYLIGHT
TRIPLE-RIVETED DURALUMIN FUSELAGE
WIND-DRIVEN GENERATOR FOR RADIO
STREAMLINED WHEEL HOUSING
RADIO ANTENNA

The recent flight of the Opel rocket plane lends timely interest to this scientific discussion of proposals to navigate the stratosphere—that bleak layer of thin air far above cloud and storm, where the stars shine as beacons and steady winds promise swift passage over land and sea.

By

ALDEN P. ARMAGNAC

Design of a high-altitude plane, as pictured by B. V. Korvin-Kroukovsky, aviation engineer. Above: The layers of the earth's atmosphere, showing how the upper levels above clouds and storms may be traversed eventually by high-flying planes in swift passage between New York and Paris.

ONE mile from its take-off, a frail plane belching a cloud of blue smoke wavered to an uncertain landing near Frankfort-on-Main, Germany, a few weeks ago. It grazed the field, scudded across it at sixty miles an hour, spun around, and turned turtle. It was damaged badly. But its pilot, Fritz von Opel, had accomplished the first flight in history in a rocket-propelled airplane.

It is a long way from the 550-pound, gliderlike craft which Opel piloted to the massive, rocket-driven cars which some theorists predict as a future development in aviation. His fragile craft, driven by twelve rockets in a steel case behind the pilot's seat, may—or may not—be the prototype of greater machines hurled through space by tons of explosive. Its greatest significance, in the minds of aviation engineers, is that it suggests one way in which a long-standing goal of aviation may be achieved.

That goal is the navigation of the "stratosphere," the upper layer of the earth's air. In that mysterious region miles above the earth, where few daring explorers have ever penetrated, the air is so thin that a human being could not live without artificial oxygen. Yet some authorities declare that the long-distance air lines of the future may be established there. Free of the resistance of air at ordinary levels, airplanes could speed across oceans and link continents at almost incredible velocity.

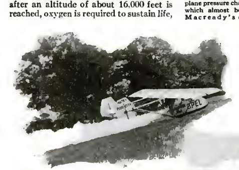
Recent proposals have been made to fly machines at such a height and speed. A young German engineer, H. G. Perl, announced not long ago his plans for a twenty-two-foot, half-ton bullet plane which he proposed to navigate at an altitude of seven or eight miles and at a speed of more than 650 miles an hour to cross the Atlantic in six hours. An Austro-German experimenter, Prof. Herman Oberth, proposes a rocket ship many times faster.

Is there really any scientific basis for such an idea—and, if so, what sort of craft may be the one to achieve it?

Today it is possible to build an airplane that will fly 60,000 or 75,000 feet high, without recourse to rockets or any such highly experimental means, in the opinion of one prominent aeronautical engineer who has worked out the details of such a craft. Other experts have endorsed the high-altitude airplane as the next logical development in air travel. A great German airplane firm is said to be planning actually to build high-altitude planes with air-pressure cabins for passengers. And eventually rockets and other inventions may conceivably augment the range of high-flying planes.

Aside from the possibility of flying to great heights, what of the great speed with which it is supposed airplanes could fly miles above the earth? Present knowledge of the thin belt of air that surrounds the earth—for practical purposes some twenty-five miles thick, though it trails off into nothing many miles beyond—bears out the idea. The few men who have penetrated into it more than six or seven miles have helped to find out what it is like. Capt. Hawthorne Gray, of the Army Air Corps, soared in his balloon to a height of 42,470 feet, the greatest altitude ever reached by a human being. He died when he attempted to repeat the feat. Another pioneer into the unknown region was the German pilot, Willy Neunhofer, whose altitude flight of 41,795 feet last May was a new world's record for air planes. From such flights as these, and from the records brought back by free-flying "sounding balloons" of the United States Weather Bureau from heights up to twenty miles or more, it is known that the air above the earth is at least a two-story affair, and that the second level has different properties from the first.

THE earth's inhabitants live in the bottom layer, or "troposphere," comprising the first six or seven miles of the atmosphere. Within this thin layer occur the storms that sweep the earth and all of the turbulent winds that threaten aircraft. Ascending from sea level, the air becomes perceptibly thinner. On a high mountain, reduced pressure causes water to boil at lower temperatures. The thinness of the air becomes painfully apparent to a mountain climber as breathing becomes difficult. And aviators know that, after an altitude of about 16,000 feet is reached, oxygen is required to sustain life, for at that height there is only half as much air as at sea level.



Belching a cloud of smoke, the Opel rocket plane roars across the field in the take-off.

With increasing height the air grows colder, until at six miles' altitude a pilot may be soaring through frigid breezes of sixty or seventy degrees below zero. Then, if he pushes upward, an abrupt change occurs at about seven miles' altitude. It gets no colder; perhaps a little warmer. There are no storms, no clouds—he has left them far below. Where he has climbed, there is always sunshine. A sky of a weird, deep blue in which the sun shines almost like the moon at night, tells the oxygen-breathing pilot that he is in that sunny, frigid, mysterious region known as the "stratosphere."

Up there at the top of the sky the air is so thin that it hardly supports the plane's wings. The motor, despite the "supercharger" that pumps compressed air into it, literally gasps for breath. But construct an airplane that could operate efficiently at such a height, and there is almost no limit to the forward speed that it might attain. The backward drag of air rushing past wings and fuselage has all but disappeared.

Moreover, smooth winds of great speed are known to exist at high levels, and these might be used to advantage by a high-flying airman. Sounding balloon observations made from a weather station near the equator revealed a powerful east wind between the altitudes of eight and eleven miles, which might add sixty miles an hour to the speed of an airplane flying from Europe to America. In the next three miles upward a strong west wind was found. Above, the direction was again reversed. Thus regular air lanes might be established at various levels, wherever the wind was found to be most favoring.

Official Photographs U. S. Army Air Corps

Equipped to climb the sky. Lieut. John A. Macready, veteran high-altitude pilot, wearing feather-lined suit, oxygen mask, and goggles treated with antifreeze.

The door of the airplane pressure chamber which almost became Macready's coffin

Flying at 70,000 feet, say, a pilot could glide with motors shut off to a landing as far away as 300 miles. It would take him more than an hour to come down. In case of trouble at sea he could radio to the nearest steamer and land alongside or near it. At that height he would always have a cloudless sky for his astronomical observations.

WILL such high-altitude air lines soon replace infrequent, courageous dashes into the upper atmosphere? Some experts think so. They agree that airplanes of new but somewhat conventional design are likely to be the first to ply such lofty air lanes and that rocket or otherwise propelled craft must follow later if at all. Not long ago Igor I. Sikorsky, famous plane designer and builder, predicted in POPULAR SCIENCE MONTHLY a "new type of airplane with highly supercharged motors and an inclosed cabin with air kept under approximately normal pressure, to permit flying at high altitudes with speeds of say 400 to 500 or more miles an hour." (P.S.M., June '29, p. 125.) Leaders in other fields, among them Prof. Albert Einstein, German relativ-

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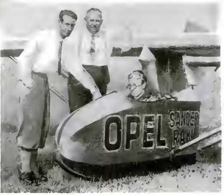


Fritz von Opel in the small cockpit of his light gliderlike craft which traveled a mile in the first rocket-propelled flight in history.

Prof. Vernon Jones, Clark University. "Few agree whether an act is right or wrong."

Dr. James R. Angell, President of Yale University. "Yale plans to establish an ape farm in Florida."

Prof. Joseph Jastrow, New York. "Criminal records may be expressions of mental states."

Why Minds Behave As They Do

"The motions of the solar system since its beginnings are less complicated than the play of a child for a day," said James McKeen Cattell, presiding over the recent International Congress of Psychology at Yale. Here are presented outstanding experiments and discoveries concerning the riddles of human behavior, as reported to the Congress.

CLOSELY following the recent sessions of the International Congress of Psychology at Yale University came the announcement from Washington, D. C., of the first step toward establishing a national center of research in problems of human and animal psychology—the National Institute of Psychology.

The incorporators of the Institute were Professor Knight Dunlap, head of the psychology department of Johns Hopkins University; Dr. Hugh S. Cumming, Surgeon General of the United States Public Health Service; and Dr. Edwin E. Slosson. Its purpose, as stated by Professor Dunlap, is to establish a national psychological laboratory to "undertake programs of research too long, expensive, and complicated for other institutions."

Following are some of the year's outstanding discoveries in psychology, as reported to the International Congress.

Secrets of Happiness

INTELLIGENCE has nothing to do with happiness, reported Prof. Goodwin Watson, of Teachers College, Columbia University. A test he gave 400 students showed fifty of them happy, and supplied data from which Professor Watson presented a picture of the typical happy person.

Such a person is likely to be a man, and married, the experimenter said. He is above the average in health, active in social life, and confident that he can tell a joke well, lead a discussion, act in a play, or direct a group of workers. His home is harmonious, he enjoys his job, and he is fond of adventure.

Factors besides intelligence which apparently have nothing to do with being happy are nationality, race, physical disabilities, financial situation of family, and ability to swim, play baseball, paint, write poetry, or draw.

Measuring Personality

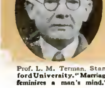
THAT elusive quality, "it," otherwise known as "personality," can now be defined and measured, Prof. Mark A. May, of Yale University, told the psychologists. It is the effect upon others of an individual's physique, his dress and manner, the quality of his voice, and his choice of language.

All these may be rolled into one, termed his "social stimulus value," and given a rating from zero to one hundred percent. For instance, a person who can enter a room without attracting the slightest recognition of his presence from others, by word or glance, rates "zero" on the personality test. He simply does not count.

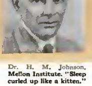
How to Sleep

SLEEP curled up like a kitten, and not stretched out like a ramrod. That was the advice of Dr. H. M. Johnson, of the Mellon Institute of Industrial Research, after investigations that disclosed startling differences with the teachings of physicians. The greatest possible relaxation, he said, is in a coil resembling a kitten's, or a sprawling posture like that of a swimmer. A badly designed or narrow bed limits the number of possible changes of position—and a typical individual shifts his position thirty-three times in a night, the studies revealed.

Children take three times as long to go to sleep as adults, Dr. Josephine C. Foster, of the University of Minnesota, reported. On the average they require twenty minutes for slumber. City children have longer sleeping hours than

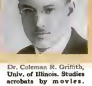


Prof. L. M. Terman, Stanford University. "Marriage feminizes a man's mind."

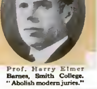


Dr. H. M. Johnson, Mellon Institute. "Sleep curled up like a kitten."

Dr. A. A. Brill, New York City. "Psychoanalysis helps strange mental cases."



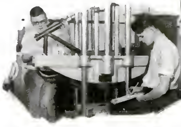
Dr. Coleman R. Griffith, Univ. of Illinois. Studies acrobats by movies.



Prof. Harry Elmer Barnes, Smith College. "Abolish modern juries."

velopment in welding is its substitution for riveting in putting together buildings, boats, machines, and bridges.

Although it was only three years ago that construction began on the first large rivetless steel building in the world—a five-story factory for the Westinghouse Electric and Manufacturing Company at Sharon, Pa.—a recent report of the General Electric Company lists sixty-five buildings, of from one to twelve stories, erected by electric arc-welding alone. Gas welding recently put up a new one-story research building at the Niagara Falls, N. Y., plant of a carbon products firm.



Experts of the United States Bureau of Standards testing the strength of welded joints of airplane fuselages.

When a towering, 134-foot addition to the power house of a hotel in Atlantic City, N. J., was erected by welding recently, some of the guests were unaware that work was in progress—and none was disturbed. Electric welding made possible the noiseless erection of some of the heaviest types of steel shapes used in building construction. The proprietor found that silence paid in dollars. His hotel operated at full capacity during the addition. A hospital at Wheeling, West Virginia, added another story to a part of its building recently by arc-welding. Fifteen feet from a table where surgeons were operating, a welder struck an arc and silently fused great beams to steel columns. The record for steel tonnage in a building put up by the arc-welding process is probably held by a recent addition to the West Philadelphia, Pa., plant of the General Electric Company. It contains 1,000 tons of structural steel.

That welded buildings are no longer an experiment, but a complete success, was the report of Prof. T. R. Lawson, of the Rensselaer Polytechnic Institute, last June, after two years of exhaustive laboratory tests of arc-welded building joints. In August a small hurricane put his assertion to the test. It hit a large packing house being erected in Florida by arc-welding. Two walls of masonry blew out, and crashed down upon the welded steel members. These twisted and buckled, but the welded joints held firm under the impact.

Welding a steel column for the new Pacific Mutual Building in Los Angeles, Calif.—an example of noiseless construction.

Buildings are not the only structures to benefit by welding. In March of last year, what is said to be the world's first arc-welded railroad bridge was opened to traffic, at Chicopee Falls, Mass. Experts estimated that a third less steel had been used than ordinarily would have been required, since the steel members were not weakened by rivet holes. A new 6,000-ton German cruiser, the *Koenigsberg*, is called the first cruiser to be all-electrically welded, the process saving about fourteen percent in weight. All new German destroyers, two cruisers, and a 10,000-ton battleship which is now under construction are to be electrically welded, it has been announced.

Three arc-welded steel motorboats, each twenty-eight feet long, built by Army engineers for use as carriers and towboats, have completed a year's service on the Mississippi River, and three more have just been added to the fleet. A 277-mile pipe line to deliver gas from Rock Springs, Wyo., to Ogden and Salt Lake City, Utah, is one of the latest of giant tubes to be arc-welded. Welding builds the world's airplanes, and of late has been increasingly used in the fabrication of industrial machinery, such as electric generator frames. Still another application is the use of welding to restore worn trolley car wheels by building up the worn parts, a process also applied to worn rails. Railroad ties have been fabricated by welding from battered pieces of railroad track that had been discarded.

Welding is used increasingly in the fabrication of huge industrial machines. Here a workman is welding the steel frame of an electric generator.

A NOVEL process depending upon welding is the application of wear-resisting alloys, notably an exceedingly tough material known as stellite, to tools that undergo rough usage. A rod of the alloy is held over the tool and a blowpipe flame applied to it sprays molten metal on the tool. The hard coating thus formed prolongs the life of the tool as much as three to five times. This process has been applied particularly to oil well drilling equipment, cement mill machinery, quarry tools, and agricultural implements.

"Atomic hydrogen" welding torch invented by Dr. Irving Langmuir, noted physicist. It combines an electric arc and a hydrogen jet.

Research on welding problems is aided by the recent discovery that the operation of welding may be photographed to new advantage by the invisible rays of infra-red, or "black" light. Experimenters long had desired to see at close range the action of different welding rods and "fluxes" used with them to control the flow of metal. But in the tiny quarter-inch cube of space at the tip of a welding rod five horsepower of heat energy is generated, and so brilliant is the light emitted around the arc and flow that it seemed impossible to observe them. A blurring glow obscured the flow of metal even when it was observed through black glass. Just when experts were ready to abandon the problem, a method used to take long distance photos from airplanes was applied to welding by a Rochester, N. Y., camera firm working with a Chicago metal concern. In this method

(*Continued on page 151*)

Can Science End Forest Fire Peril?

By ALFRED P. RECK

When trees become torches—a fire at night in Columbia National Forest, Washington.

Digging a fire-line trench to save heavy timber in Pike National Forest, Colorado.

Sighting a fire with alidade and map in the Striped Peak lookout station, Coeur d'Alene National Forest, Idaho.

TWENTY dollars a minute is the average sum our Government must spend, year after year, to combat forest fires. Fire can destroy in a week as much timber as lumbering companies can cut in a year.

In 1928 forest fire damage totaled $82,934,000. There were 177,362 fires, of which 40,579 were in the protected area of federal forests and national parks. Altogether 43,931,000 acres were burned over during the year.

For 1929, United States Forest Service officials estimate that all of these figures will be doubled. Because of nation-wide dry weather this has been the worst fire year since the disastrous western fires of 1910. If the estimate turns out correct, the Red Menace this year will have cost the United States more than $160,000,000 with nearly one hundred million acres of land burned away. A terrific damage. Experts agree that something must be done to stop the waste, but what?

If science can help fight forest fires in other ways besides those now used, Forest Service officials say they will be delighted to know them. So far the rangers and the "smokechasers," or guards, have found nothing to stop a crown fire—one that leaps from tree top to tree top—except a drenching rain or for the fire to burn itself out, and nothing better for a duff or undergrowth fire than trenching and backfiring.

The Forest Service has tried chemicals, but chemicals are useless unless the fire is confined where they can blanket the flames. It has tried airplanes, but airplanes cannot reach the source of undergrowth fires, and in a crown fire the heat is so intense that the planes cannot approach close enough to aid.

Science, however, has contributed valuable warning instruments to the fire fighters. Chief among these are the sling psychrometer, for recording the humidity of the atmosphere, and the duff hygrometer, for indicating the percentage of moisture in the ground debris. The sling psychrometer, which every ranger is taught to use, consists of two thermometers, one wet bulb and the other dry. The ranger swings this through the air for a few seconds, reads the mercury in the two thermometers and, by comparing the readings with a printed scale, is able to determine the relative humidity of the air.

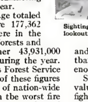
The duff hygrometer resembles a gage on the end of a long hollow spike, dotted with holes. This spike is inserted in the ground debris—pine needles, leaves, and so on—and an expanding and contracting rattan coil registers the moisture percentage.

Studies conducted by Forest Service experimental stations have shown a humidity of twenty-five percent, or lower, highly dangerous, and of sixty percent, or above, safe. Below twenty-five percent is a condition ripe for a crown fire.

Similar experiments have shown that when the topmost layer of duff has less than ten percent moisture, any source of ignition producing the same heat as an ordinary match can raise the duff to the kindling point. At less than seven percent moisture, the duff may be freely ignited by locomotive sparks or a glowing cigarette butt. At twenty-five percent the duff is generally safe from any of the common causes of forest fires, except possibly lightning. One lightning storm has been known to start as many as 400 separate forest fires.

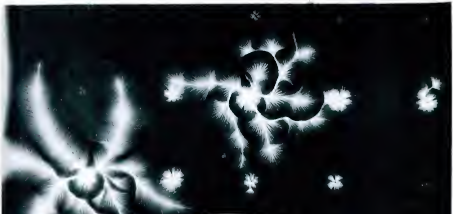
For quick and accurate locating of fires, the rangers use movable sights mounted on flat maps in the lookout towers. These are known as alidades. When a fire breaks out the readings of the alidades sighted on the fire from separate towers are reported by telephone to the supervisor's office, where the exact location of the fire is determined by simple triangulation.

Careless people cause most of the forest fires. Out of 40,000 recorded in the protected area last year, 8,346 were caused by discarded cigar or cigarette butts and 3,681 by neglected camp fires.



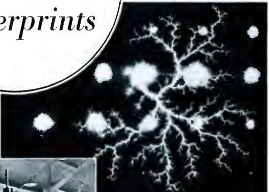
A spectacular night photograph showing the line of a brush fire descending a mountain side north of Santa Paula, Calif. At right: The duff hygrometer for measuring moisture in ground debris. Above: The sling psychrometer for recording humidity, used by rangers to forecast forest fire weather.

Lightning's Own Fingerprints



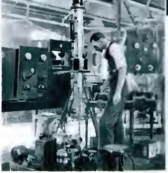
As symmetrically beautiful as snowflakes are the fingerprints of lightning shocks to power transmission lines, recorded by the klydonograph. Above is a camera record of a negative surge of lightning.

John F. Peters, inventor of the Westinghouse klydonograph, an ingenious eight-day camera which gathers evidence of the nature of lightning by high speed photographic records. He is shown here with an early model of the device.

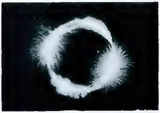


A positive surge of lightning. Study of the lines reveals the peak voltage of the lightning stroke, how fast it grew, polarity, and direction of travel.

The latest type of klydonograph, with eight-day film. Lightning acts in a few millionths of a second, but this instrument has photographed artificial surges which lasted less than ten billionths of a second.

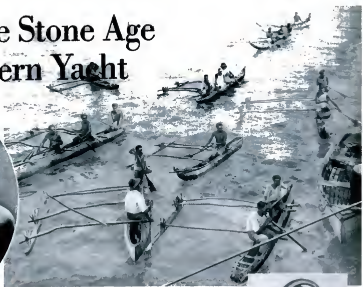


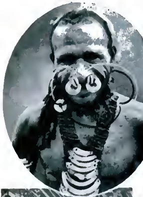
A klydonograph station under a transmission tower. It stands on guard day and night to record thunderbolts that cripple power lines.



A lightning bolt's autograph in the form of a ring. By studying its characteristics revealed by the size, intensity, and arrangement of lines, scientists hope eventually to find ways of combating the destructive effects of lightning.

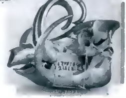
Back to the Stone Age in a Modern Yacht



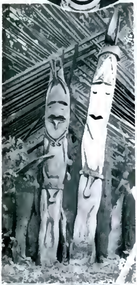


New Hebrides natives swarming about the *Illyria* in their frail dugout canoes. Left: A fierce warrior of the Upper Sepik River in New Guinea. He posed only after the promise of a steel knife.

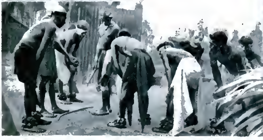
ON FAR-OFF islands of the Pacific, north of Australia, live savages in conditions as primitive as those of the Stone Age. Many never had seen a white man until visited by the expedition of scientists which obtained these photographs. On a 30,000-mile cruise in the yacht *Illyria*, owned by Cornelius Crane, of Chicago, this expedition obtained specimens for the Field Museum of Natural History. The natives pictured inhabit the islands of New Guinea, Celebes, and the Solomon and New Hebrides groups.



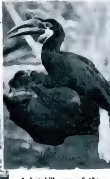
Skull of a babirussa, or wild pig-deer, found only in the Celebes Islands.



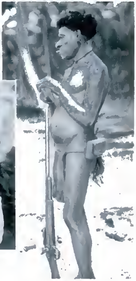
Resembling Alaskan totem poles, carved figures stand at a native shrine, where sacred boar tusks are kept.



A war dance by bush natives of Espiritu Santo Island. Although a war was in progress when the Crane expedition arrived, the party received friendly treatment.



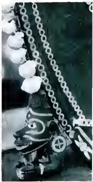
A hornbill, one of the strange birds captured alive by the expedition. The female sometimes is imprisoned in a hollow tree nest and fed by its mate through a hole.



A typical New Hebrides bush native ready for combat. A few days before this picture was taken, Crane and a small party visited a village of cannibals who never had seen a white man.

The exploring yacht *Illyria* on the Sepik River, 400 miles into the heart of New Guinea. From this point the party ascended the Mai River in small boats, reaching a wild district where the natives, still living as did our ancestors of the Stone Age, threatened them with spears and arrows until pacified by gifts.

What the better dressed natives of New Guinea wear when fixed up in their "Sunday best." This party paid a friendly visit to the *Illyria*. Note the nonchalant manner in which one woman is lighting her pipe.



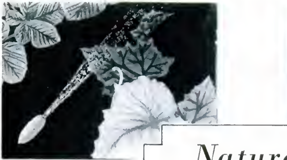
The elaborate figurehead of a native war canoe, made as hideous as possible to terrify the enemy. The designs are mother of pearl inlay.

Trading with New Guinea savages on the Upper Sepik River. Cornelius Crane, sponsor of the cruise, stands at the left. The natives would sacrifice anything but their wives for articles made of steel.

This Wogumasch chieftain barred the party from landing, fearing they would carry off the women.

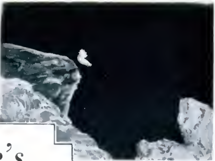
Women of Sowa, Ysabel Island, staging a dance which is part of their tribal rites. Those white heads that are so conspicuous are the result of bleaching, for even in the Solomon Islands it appears that gentlemen prefer blondes.

A study in contrasts. Sidney N. Shurtleff, of Boston, photographer for the expedition, with five chiefs of the bush tribes dressed in full regalia at Malo, New Hebrides. They bartered ancient carvings and sacred boar tusks.



One of the most ingenious of Nature's devices for seed distribution is found in the Echallium, or squirting cucumber. Its seed case is fashioned as a sort of hydraulic gun. When the fruit is ripe it bursts from the stalk and violently shoots out its tiny seeds, sometimes to a distance of thirty feet.

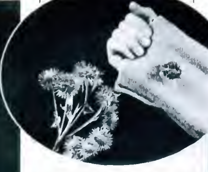
Nature's Seed-Sowing *Machines*



Attached to a falling leaf from its mosslike parent, the tiny young stonecrop bounces down the hillside, as pictured here, until it reaches a suitable cranny for its home. The leaf acts as a cushion during its tumbling journey, in which it encounters crevices not attainable in a straight

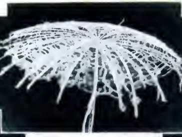
From a film in British Instructional's "Secrets of Nature" Series

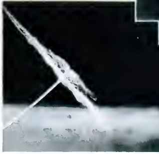
The young stonecrop all settled in a safe crevice after its tumble down the hillside. Here it begins to grow, meanwhile drawing its water supply from the fallen leaf of the parent plant, to which it is still firmly attached.

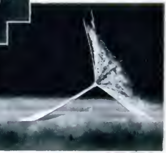


The seeds of the burdock steal a free ride. The seed case is armed with clinging hooks by which it attaches itself to any man or animal passing by. Here a sleeve, brushing against a burdock plant, has picked up a bundle of seeds for distribution.

The seed of the thistle is shot to earth like a bomb. The seed case, floating on its feathery parachute, contains an elastic ring into which part of the seed fits. When it hits a tree, as above, the ring contracts, expelling the seed.







These three photos show the remarkable way in which the parachute seed case of the goatabeard lands the seeds in a suiteble spot for growing. The parachute opens to sunshine (left) and closes with dampness (right). When it sails over a damp spot, good for growing, the parachute closes and sinks to earth. If it strikes an unsuitable spot, the alternate actions of sun and dew, opening and closing the parachute, make it creep along until it reaches ground that is good for sprouting purposes.

CLIMBING to the World's Roof Tops

A mountain climber must have the agility of a broncho-buster to scale some of the cliffs of the Tyrol Alps in Austria. From a perilous toe hold this one has lassoed a projecting rock and is pulling himself up to safety.

Members of a Russo-German scientific expedition descending the treacherous ice of Fetschenko glacier, fifty miles long, which they discovered recently in the wild Pamir mountain region of Turkestan.

The mountaineer-explorers, carrying alpenstocks and wearing smoked goggles, cross the gleaming face of Fetschenko glacier. This sea of ice in Central Asia, cloven by dangerous crevasses, is reported to be the largest ever found outside Arctic regions.

A view along the "roof of the world" in Central Asia. Picking their way along a carpet of jagged ice, members of the Russo-German expedition are seen advancing toward the highest peaks of the Pamirs, the greatest of which rises 22,000 feet.

In oval above: Explorers of the Central Asiatic expedition fording the salt waters of Kara Kul lake in the course of their mountain-climbing adventures among the Pamirs. This body of water, lying at an altitude of about 13,000 feet, is said to be the largest salt-water lake in the world.

Left: Mountain climbers viewing the roof line of the Sierra Nevada range from an observation platform in Sequoia National Park, central California. Among these snow-capped peaks rises Mount Whitney, 14,502 feet high, the loftiest mountain peak in the United States proper.

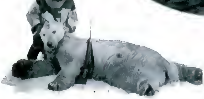
Science *and* Tragedy *in the* Arctic

HERE are pictured the adventures of two recent expeditions into the Arctic. One was a walrus hunt to obtain specimens for the Field Museum, Chicago. The other was an ill-fated attempt by a Norwegian fishing fleet to break a path through the ice for seal hunters.

A polar bear caught by the Field Museum hunters and hauled by block and tackle aboard the schooner *Dorothy*.

Members of the crew of one of the Norwegian vessels with bear cubs they captured on the ice north of Spitsbergen.

From a lookout post in the rigging of the *Dorothy*, George Coe Graves II, one of the leaders of the Field Museum hunt, searches the ice for polar bears and walruses.



Bruce Thorne, co-leader with Graves in the Museum expedition, with his first polar bear, a huge animal nearly 11 feet long.

The *Quest*, flagship of the Norwegian fleet, locked in the Arctic ice. Of ninety vessels which attempted to open a lane for seal hunters, about half were sunk or crushed. Many lives were lost.

One of the Norwegian fishing vessels hemmed in by ice. The ships which survived the impact of the drifting ice returned to Norway heavily loaded with bears, seals, and other Arctic game.

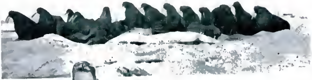
Three baby seals, four weeks old, sunning themselves on Arctic icebergs, snapped by Daniel Troutwein, photographer of the Norwegian fleet.

A black seal fast asleep on a sunny ice cake and entirely unaware that its picture was being taken at close range. These land and water mammals are hunted for fur, hides, and oil.

A desperate moment in the battle with the ice. The crew escaping from one of the foundering Norwegian vessels, crushed in the grip of the Arctic. About fifty men of the crew of 300 in the fishing fleet were lost.

The *Quest* plowing through the tumbled masses of ice. At times progress was impossible. The expedition, financed and directed by the Norwegian government, was forced to abandon the attempt before reaching its goal.

Two fine specimens of walrus obtained for the Field Museum of Natural History in Chicago by its Arctic expedition. The hunters found it necessary to kill them instantly with the first shot; otherwise the wounded tuskers would slip into the water and quickly vanish.

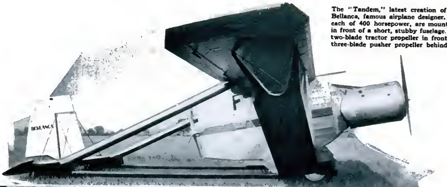


A group of walruses awakened from their daily nap on the ice. The Museum hunters found them very numerous this year, several thousand being seen. A full-grown male tusker measures ten to eleven feet in length.

Daniel Troutwein, the photographer and radio operator of the Norwegian expedition, holding a baby seal which he captured on the ice.

Two of the Norwegian hunters dragging captured seals back to their ship across the sea of jagged ice. This remarkable photograph gives an idea of the desolate expanse of the Arctic into which the fleet of vessels plowed their way in search of the big game of the Far North.

Keeping Pace with Aviation

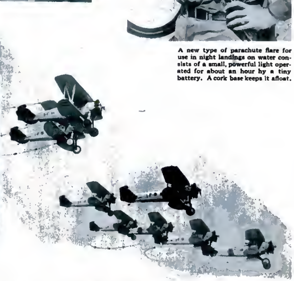


The "Tandem," latest creation of Giuseppe M. Bellanca, famous airplane designer. Two engines, each of 400 horsepower, are mounted in tandem in front of a short, stubby fuselage. One drives a two-blade tractor propeller in front; the other, a three-blade pusher propeller behind the fuselage.

One of two huge 30-passenger Dornier flying boats assembled at the Philadelphia Navy Yard for the Stout Airlines. It is 80 feet long with 90-foot span, and is patterned after 100-passenger Dornier flown in Germany (P. S. M., Oct. '29, p. 45).

A new type of parachute flare for use in night landings on water consists of a small, powerful light operated for about an hour by a tiny battery. A cork base keeps it afloat.

Members of Los Angeles County Forestry Department, California, inspecting smoldering cigarette and cigar butts dropped from a plane in tests to determine if aviation increases forest fire hazards. Sixteen of thirty stubs were found burning.



Flying tied together. A remarkable formation exhibited by the "Aerial Armada" from the U. S. S. *Saratoga*, crack acrobatic squadron of the United States Navy. Stout ropes join the planes

Radical Changes in Plane Design—A New Safety Parachute—A Speed Record, Six Miles a Minute

STARTLING departures in airplane design have recently challenged the supremacy of the conventional modern aircraft.

Strangest among them, perhaps, is a monoplane which recently took the air at New Castle, Del., and which appears to have heen shorn of most of its fuselage. It is the latest contrihution to aeronautics of Giuseppe M. Bellanca, famous airplane designer and manufacturer. As pictured on the opposite page, outriggers from the wings support the tail in a manner reminiscent of the primitive planes of twenty years ago. A tractor propeller in front and a pusher propeller in back propel it. The design is said to provide great load capacity with unimpaired maneuverability.

Two short wings in front and two large ones in back distinguish a remarkable "tandem" plane invented hy George Fernic, of Staten Island, N. Y., and recently flown successfully for twenty-two minutes at Roosevelt Field, N. Y. It is designed to carry eight passengers, and its inventor claims a cruising radius of 6,000 miles.

Another queer plane, huilt by a Cleveland, O., designer, enables a pilot to alter the curvature of the wings in flight.

A New Parachute

IN ITS efforts to improve the safety of aerial devices, the Materiel Division of the Army Air Corps has evolved a new type of parachute. In material, size, and principle of operation, the new 'chute is exactly like the old. Instead of a circular mainsail, however, it has a triangular one.

This triangle is rounded at two corners, while the third is sheared straight across. Although the new 'chute has twenty-four shroud lines, spaced about a yard apart, none is attached to the sheared-off corner, so that when the 'chute is open this corner forms a tail-like vent through which the air escapes. This gives the 'chute a forward motion at about three or four miles an hour. It can be steered by manipulation of the shroud lines. A second vent, circular in shape, at the apex of the mainsail, is fitted with a valve that opens automatically when the parachute opens, thus reducing the shock on the jumper.

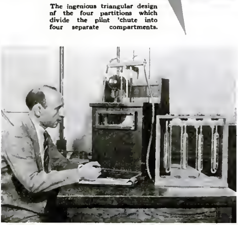
A radical change has been made in the construction of the pilot 'chute which opens immediately when the rip cord is pulled and draws the main 'chute along with it. Instead of resembling a miniature umbrella, as does the standard type when inflated, the new pilot 'chute looks like a box with four compartments. The partitions project about fifteen inches over its edges. They are four right-angled triangles sewed together at a common perpendicular at right angles to each other. Thus, when opened, it resembles four small parachutes joined together.

Though the triangle parachute has not yet been officially adopted by the Army Air Corps, about a dozen live jumps have heen made with it and over a hundred "dummy" jumps.

How the new triangular parachute is folded in its pack. The pilot 'chute, divided by partitions is at the right.

The parachute opened, with pilot 'chute attached. At the apex is an air vent which opens automatically to break the shock for the jumper.

The ingenious triangular design of the four partitions which divide the pilot 'chute into four separate compartments.



Measuring the flowing qualities of sample liquids in the United States Bureau of Standards, in laboratory tests to find a new fluid which, when used in airplane compasses and inclinometers, will withstand the extremely low temperatures encountered at high altitudes.

Six Miles a Minute!

FASTER than any human heing ever traveled before, Squadron Leader A. H. Orlebar, British flying ace, recently whizzed over a Calshot, England, flying course of nearly two miles at 368.8 miles an hour—more than six miles a minute! This was the official figure which was averaged with his time on three other laps to obtain the average speed for the course according to international rules. The result, an average of 355.8 miles an hour, he surpassed two days later with a new average, of 357.7 miles an hour, a world speed mark.

At the speed of his record lap he would require less than nine hours to fly from New York to San Francisco. So completely streamlined was the hlue-and-silver Supermarine S-6 seaplane in which he flew that even the many tiny bracing wires were shaped in profile in order to afford the least possihle resistance to the air.

Aviation experts point out that the speed of airplanes has increased by 326 miles an hour in the last sixteen years. In 1913 a speed of forty-two miles an hour was fast enough to win an international race. Today Louis Bleriot, first pilot to fly across the English Channel, predicts a speed of 750 miles an hour by 1939.

Latest Air Words

"FOUR hours after I enplaned in Buffalo, I deplaned in New York." Such sentences may be common in conversations of the future. Two new flying words growing out of air transportation are to be included in the latest edition of the New Standard Dictionary. They are "enplane," meaning to board a plane, as "entrain" means to take a train, and "deplane," meaning to alight from a plane.

Novel Equipment

OVERHEAD control sticks and superchargers for commercial planes are among the novelties revealed by a survey of recent advances in American airplane equipment.

The joy stick suspended from above is a feature of a new tri-engined, six-passenger cabin monoplane. Its Detroit, Mich., manufacturer plans to equip

Future women pilots receiving first instruction in new ground school for women recently opened at New York University. S. J Donohue (center) is the instructor.

future models with an overhead control of wheel type.

Superchargers, power-boosting devices hitherto employed almost solely on planes seeking altitude records, are now perfected for commercial use. One type is expected to be installed in twin-engined amphibians produced by a Cleveland aircraft firm.

An open "office" plane for flying business executives is equipped with a sliding windshield that can be drawn out to cover the cockpit and permit the handling of papers. It is a companion to cabin planes equipped with desks, typewriters, and dictaphones, made by several firms.

Landing wheels that fold into the body during flight to decrease wind resistance are features of several new models. Geared engines have appeared. A recent innovation is an "air wheel," a wheel for planes that consists of a huge tirelike pneumatic ball pierced by a tiny hub. It combines wheel and shock absorber.

A Shield from Lightning

A GIANT gas bag with a "wire fence" surrounding the basket marks the latest advance in balloon design. The hanging wires are intended to act as a protection against flashes of lightning. This lightning shield was invented by Ward T. van Orman, famous aeronaut, who piloted the new balloon in the Gordon Bennett Trophy Race. It is called the *Goodyear VIII*, and represents seventeen years experience on the part of the company constructing it.

Few major improvements have been made in the balloon since 1783, when the French scientist, Professor Charles, made his first ascent. The ripping panel, allowing the bag to be emptied speedily upon landing, and the drag rope, keeping the balloon at an even altitude, have been the two most important innovations in balloon construction in the last 150 years. If the lightning shield proves effective, it will be counted another major advance.

Ice Anchor for Dirigibles

POLAR ice caps would anchor dirigibles in a novel scheme suggested by a German engineer, O. Krell, and inspired by plans tentatively announced for a polar flight, in the near future, by the German airship *Graf Zeppelin.*

An electrically heated plate-shaped anchor would be used. Cruising over the ice fields, the dirigible would drop its anchor and hover while the hot plate sank into the melting ice. Then the electric current would be shut off, and the ice would freeze and hold the dirigible. Men and material could then descend via the anchor rope. When the dirigible was ready to leave, the electric current could be turned on once more and the anchor would pull loose from the melted ice.

First Aerial Billboard

WHAT is said to be the first aerial advertising billboard in the world has just been erected near Detroit, Mich. Its tilted sign, visible both to highway travelers and to passengers who fly overhead from the local airport, advertises the merits of a brand of motor gasoline and oils. Sky riders say that its message is clearly readable from a plane flying at a height of 700 feet.

A new scheme of "air-marking" to direct pilots is suggested by Harry H. Blee, chief of the airports division of the United States Department of Commerce. Highways afford the best place for aerial signposts, he says, since a pilot may then follow a road as a guide when flying over unfamiliar territory. Chrome-yellow or white letters ten to thirty feet high, painted on the highway, would tell him its official route number.

Air Taxi—20 Cents a Mile

TAXI service by airplane to any part of the United States at a proposed rate of twenty cents a mile has just been announced by a New York City concern, which planned to start operation within a few weeks. There are no time-tables, nor fixed rates for a trip. The new line, of which a New York taxicab firm is said to be a principal owner, simply charges a regular mileage rate like that of auto taxicabs in cities.

Auto cabs and motor boats will be coördinated with the new service, it is said, in order to pick up the passenger at his doorstep and deliver him exactly where he wants to go. A similar service at a shilling a mile is announced by a British firm that plans to carry "fares" over England in planes just big enough for one passenger and his baggage.

To commemorate the twentieth anniversary of the first airplane crossing of the English Channel, the plane in which Louis Bleriot made the flight recently was placed in the Science Museum, London. Here mechanics are assembling the plane.

Mail Pick-up in Service

FOLLOWING recent demonstrations of a device that enables pilots to pick up and drop air mail without stopping, the first of these devices has been placed in actual service on a Cleveland-Pittsburgh air mail line. It is the invention of Dr. L. S. Adams, of Spokane, Wash. A speeding plane approaches the mail station swinging a weighted cable from its under side. A V-shaped trap on the ground directs the cable into a slot, where it hooks to a bag of mail and is then drawn up by the plane. In the same way a bag of mail attached to the cable is dropped off.

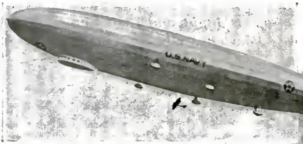
Several practice flights preceded the inauguration of the regular service, which is expected to cut time from the mail schedules.

Making Big Planes Safer

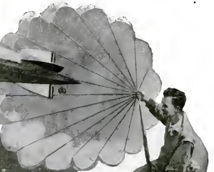
A DEVICE to disconnect the propeller of an airplane from its shaft so that it may revolve freely is a simple but ingenious invention recently given to his government by Sensaud de Lavaud, French aeronautical engineer. The result is said to be an increase in safety.

Some aeronautical engineers have claimed that a two-motored plane is little safer than a ship with a single motor, since if one engine fails the other may have difficulty in pulling a loaded machine. De Lavaud's invention eliminates the wind drag of the stationary propeller attached to a stalled motor. By allowing it to revolve freely, the wind resistance is materially cut down and the work of the remaining engine lightened correspondingly. The mechanical principle of the device is not unlike the "free-wheel" arrangement that allows a bicycle to coast without turning the pedals.

Aircraft and Flying Feats Out of the Ordinary

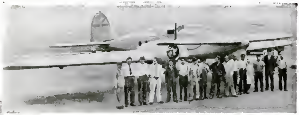


A Navy biplane hanging by a trapeze from the great dirigible *Los Angeles* during a recent demonstration of the airship's ability to pick up and dispatch planes in flight (P.S.M., Nov., '29, p. 42). A Naval officer was transferred to the plane, which then landed him.



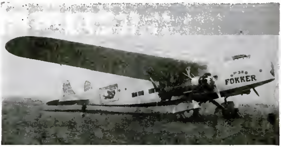
Mail dropped by parachute from the air mail plane *Shuttle* during the recent attempt of Capt. Ira Eaker to pilot the plane to a new transcontinental refueling endurance record.

At the left is a novel parachute basket invented by Captain Cragomir of Rumania. The basket is incorporated in the hull of a plane, where it serves as a seat. It is released automatically.



The unusual new "tandem" plane invented by George Fernic, of Staten Island, N. Y. It is distinguished by two short wings at the nose and two large ones behind. In a recent test at Roosevelt Field, N. Y., it flew successfully for twenty-two minutes.

Fitted with pontoon and landing wheels, this new Navy amphibian plane, with 425-horsepower motor, can light on land, water, or the deck of an airplane carrier. The landing wheels, operated from the cockpit, may be raised or lowered, or may be tucked away in the pontoon when not in use. Above: Inspecting the new craft at the Naval Air Station, San Diego, Calif. Upper view shows the amphibian taxiing on water with wheels in flying position.



Anthony Fokker's newest creation, a giant thirty-two-passenger monoplane, photographed during its first public test flight at Fokker Field, N. J. Largest land plane in the world, it will be used for transcontinental passenger service. Four 425-horsepower motors drive it at a cruising speed of 120 miles an hour.

The Moon Is Made of Cinders

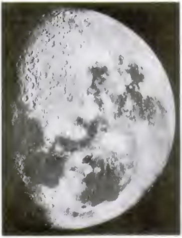
Ingenious Measurements of Its Light and Heat Reveal the Old Man's Pocked Face Powdered with Volcanic Dust

By THOMAS ELWAY

INSTEAD of the silvery moon that poets praise it would be truer to talk about a cindery one. Cinders, the latest scientific researches indicate, are what the moon's surface is made of; a special kind of cinders like those thrown out of earthly volcanoes and called pumice or volcanic ash. If there were any air on the moon to get up a wind, a moderate tempest might blow away the Man in the Moon overnight, for that imaginary portrait is "painted," it is probable, in vast hundred-mile brush strokes of soft, loose pumice and still looser dust.

The chief evidence for this comes from the moon thermometer perfected a few months ago at the Mount Wilson astronomical observatory of the Carnegie Institution, near Pasadena, California. This instrument is a delicate device for measuring heat rays, attached to one of the great Mount Wilson telescopes. Similar instruments (thermocouples), based on the property of certain pairs of metals to produce electricity when the joint between them is heated, were used several years ago by Dr. W. W. Cohlentz, of the United States Bureau of Standards, and by other scientific men, to measure the temperature of the planet Mars.

For many months Dr. S. B. Nicholson and Dr. Edison Pettit of Mount Wilson have been using the thermometer on the moon. When the sun shines on it, the moon's surface gets very hot. After sunset on the moon the surface begins to cool. That is how the fact that it consists of some porous material like pumice has been discovered.


A remarkable photograph of the half-moon taken with the 100-inch reflector of Mount Wilson Observatory. So clear are the craters and the darker, flat looking areas called "seas," that they can be mapped quite definitely, as on the opposite page.

DIFFERENT kinds of rock take up heat or lose it at very different rates. A piece of polished marble, for example, feels cold if touched to the skin because marble absorbs heat rapidly, takes this heat from the skin and cools it. A block of pumice feels much less cool because it absorbs heat less rapidly. By delicate measurements with the moon thermometer, the Mount Wilson scientists were able to calculate how fast the moon's surface warms up when the sun first strikes it and how fast it cools off when the sun's rays leave for the night. With these measurements as a basis, Dr. Paul S. Epstein, a physicist of the California Institute of Technology, conducted experiments with various kinds of earth rock in his laboratory. Heating them and cooling them, he compared the rates which they displayed with the heating and cooling of the moon. Granite, black lava, quartz sand or sandstone; all were very different from the moon rate. Pumice, blown out by earthly volcanoes, was almost exactly the same. Thus he found that if the surface of the moon is not actually made of this pumice, it evidently consists of something which heats and cools in precisely the same way.

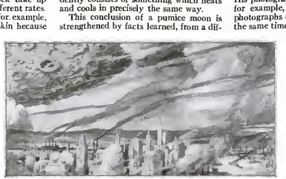
This conclusion of a pumice moon is strengthened by facts learned, from a different method, by Dr. F. E. Wright, optical expert of the Geophysical Laboratory of the Carnegie Institution, in Washington, D. C. Dr. Wright made use of the moon's light which consists, of course, of reflected sunlight. The reflected moon rays are not quite the same in character as the original sun rays. Colors have altered slightly. The percentage of the special kind of light called polarized light is increased. Presumably still other changes occur. Measuring these modifications of sunlight into moonlight, Dr. Wright and his associates compared the similar changes in sunlight produced by its reflection from small laboratory samples of various kinds of rocks.

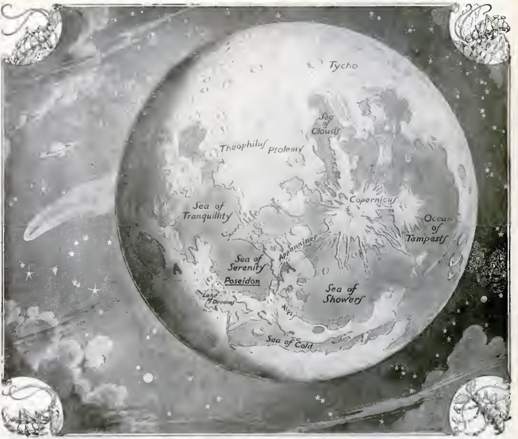
As in the California experiments, the one kind of rock which seemed most like the moon in light reflection as well as in heating and cooling was the same volcanic pumice. The conclusion is that the moon's face is sprinkled with a face powder of volcanic dust.

TWO earlier opinions of astronomers are confirmed by these new facts. One is the absence of a moon atmosphere; for winds or rainstorms on the moon would change this loose surface dust continually, giving the moon a new face every week. The other is the idea that the mountains and great plains and crater like circles visible when the moon is examined with a telescope are really volcanic, just as they seem to be.

The conclusion that the moon is airless has had recent confirmation, too, from Dr. W. H. Wright of Lick Observatory, in California. For several years he has been photographing planets and other astronomical bodies by light of different colors. His photographs of Mars by violet light, for example, are distinctly larger than photographs of the same planet made at the same time and through the same telescope but with red light. The explanation is that violet light photographs the atmosphere of Mars as well as the planet's solid surface. The red light photographs the surface only; which appears, of course, slightly smaller than the planet and its atmosphere taken together.

Recently Dr. Wright applied this method to the moon. No difference of size was detected. Photographed by red light or violet light, the moon looks just the same. The evidence seems conclusive that the moon


A giant telescope to be erected in California will bring the moon's surface within an apparent distance of twenty miles of the earth. The artist portrays here how its pocked, cindery face might appear if it actually came that close to the earth.



Compare this map of the moon's face with the photograph on the opposite page. The great ring-mountain Copernicus is more than 50 miles in diameter. Crablike creatures such as those in the smaller pictures may possibly live on the moon.

has either no atmosphere at all or an atmosphere which is nearer to a perfect vacuum than the inside of the most completely evacuated radio tube or electric lamp.

The volcanic theory of the moon's features, now supported by definite evidence, has gradually been gaining ground among astronomers. The moon was formed, astronomers and geologists now agree, out of a large fragment of the earth's crust, pulled loose by extreme tidal action in the early days of the earth's billions of years of history. Whether these earth fragments were hot when detached, the violence of such a cataclysm would be reasonably sure to heat them, so that the original moon must have been hot internally, if not outside. Dr. Harold Jeffreys, distinguished British authority on earth history, computes that the moon probably has in its interior considerable heat-producing radium. A hot moon naturally would be volcanic, just as some remnants of primeval or radium-created heat still blow off occasionally through the earth's volcanoes.

Other theories proposed to explain the vast, volcano-shaped ring mountains of the moon's surface are less plausible. One ascribes the ring mountains to the fall of gigantic meteorites in past ages, raising ridges of rock around the edges of the holes. Recently a Russian exploring party located a similar crater in Siberia, where a gigantic meteorite once hit the earth. This crater is far smaller, however, than most of those on the moon, and there are other reasons for deeming the meteor theory insufficient.

Because of weaker gravity, an erupting moon volcano (A) would far outshoot one on the earth (B).

IN ENGLAND, the distinguished amateur astronomer, H. G. Tomkins, is sponsor for the idea that the moon mountains may be the remains of gigantic rock bubbles, lifted ages ago by accumulations of gas underneath, as internal gas lifts the domelike shapes of dough when the cook makes "popovers." In time, he believes, the domed roofs of rock broke and fell in, leaving only the circular walls. The theory is an ingenious one, but critics point out that it is difficult to imagine such rock domes fifty or sixty miles across and still able to stand up by mere pressure of a vast gas bubble underneath.

The enormous size of the moon craters constitutes, indeed, the chief difficulty in explaining them. The lunar ring-mountain which terrestrial astronomers call Copernicus is more than fifty miles in diameter and with walls nearly four miles (*Continued on page 143*)

"How I Fly My Plane"

After 4,000 Hours in the Air, Lindbergh's Former Partner Tells How He Solves the Problems Every Flyer Must Face

By RANDY ENSLOW

THE queerest flying accident I ever had happened in Ohio. I was barnstorming in an old Standard biplane—a ship that was braced with enough wire to bale ten tons of hay. I could test it by letting a pigeon loose between the wings. If the bird found its way out, I knew a wire was gone somewhere!

While flying cross-country between two towns, I lost my way. I set the ship down in a field about the size of a handkerchief to get my bearings. I had to take off over a clump of trees. But in barnstorming, a pilot gets used to landing on a postal card and taking off from a stamp, so I wasn't worried. But just before I tipped the trees, a flock of crows that had settled there was scared up by the roar of the plane's motor. The air became black. A dozen struck the propeller. It went to pieces, exploding like a firecracker. A black blizzard of crow feathers blinded me. The motor choked dead. I shoved ahead on the stick and down we came in a pasture beyond the trees. In landing, we almost milked a cow and sat down straddling a barbed wire fence. But after I dug pieces of crow out of the motor's air intake and put on a new "prop," the ship was ready to go.

It is when something unexpected like that pops up that a flyer discovers whether he is running a ship or it is running him. And the only way to get by with an airplane is to run *it*, all the time. Thirteen years in the air has taught me that, if nothing else.

TODAY, when I dropped down at Curtiss Field, Long Island, after ferrying a new Robin in from Schenectady, I totaled up my log hook and found I have been in the air a little over 4,000 hours. Less than half a dozen people in the world have that much flying time. I began flying at fifteen. I have piloted every type of ship made in America. I have seen every state in the Union from the air, except West Virginia. And I am going down there next month. But the record I am proudest of is that I have trained 500 students and not one has hurt himself or anyone else as far as I can check, and I've kept close watch.

One of the first lessons a pilot has to learn is to keep track of the condition of his ship. Taking off in a crippled plane is about as safe and sane as going over Niagara Falls in a leaky rowboat. Even expert mechanics slip. Once one hooked up the elevator flippers on "Merry" Merrill's plane wrong. When the ship was supposed to climb it dove, and vice versa. Merrill was racing another pilot off the ground. The result was one of the sweetest somersaults you ever saw. So a pilot should go over his plane himself before leaving the ground. We all get careless about that. But when we do, we pay sooner or later.

My own lesson came early. It was the year after I barnstormed with Lindbergh. I was testing ships for the Robertson Aircraft Corporation at Lambert Field, in St. Louis. The mechanic gave his "O.K." on a new biplane job, and I jumped in without looking her over. Five hundred feet up, the whole balancing aileron on one wing sailed off into space! The mechanic had forgotten to put in any of the hinge bolts. The wing, without any balancing surface, began to tip—and how! I pushed the nose down in a spiral, then climbed out of my seat, perching on the fuselage back of the cockpit with my hands braced against the struts in front of me. If the motor poked back through the cockpit, it wouldn't find me! We crashed on one wing and the nose. The ship was a wash-out, but I was only shaken up.

By studying the different colors of fields below, Enslow tells which offers the best landing spot. In circle: By looking into the sky he can tell the wind direction.

The part of a plane that needs the most attention is, of course, the motor. It pays to treat a motor right. It would take a human heart more than a month to beat as many times as a nine-cylinder engine explodes in a single ten-hour flight. Lindbergh's Wright Whirlwind exploded twelve million times, without a rest, on his flight to Paris.

I always warm up my motor gradually

before a take-off. The first minute, I let it idle along at 600 revolutions. Then I speed it up to 1,000 and keep it there until the motor thermometer shows an oil temperature of ninety degrees F. The instrument on the plane that indicates how many revolutions the propeller is making is the tachometer. When a propeller breaks in the air, the tachometer hand shoots over to 3,000 as the motor races. The vibration nearly shakes the fillings out of your teeth. But it doesn't last long. The motor sucks gas faster than the carburetor can supply it and stops. If half a propeller breaks off, the pull of the other half often tears out the engine before you can jerk back the throttle.

At CRUISING speed in the air, the tachometer shows from 1,450 to 1,500 "revs" a minute. By watching the thermometer, the oil pressure gage, and the tachometer, I keep track of how my motor is functioning. Increased vibration or a change in the sound of a motor will often warn that it is getting "rough" and may give trouble.

Some pilots start with the motor oil temperature at forty degrees. But they take a chance. A cold motor may quit over the edge of a flying field—usually one of the worst places in the world for it to quit. In such a case, it is almost always best to land straight ahead, even if there is a stone wall in the road. Turning back at low altitude with a dead motor usually means a bad crash.

One of the most ticklish landings I remember was made just outside a flying field in Michigan. It was the dead of winter. I was taking off with a passenger. The motor quit over a maze of tracks, highways, and telephone wires. The only field near enough to be of use was a little potato patch with the frozen ridges running at right angles to the wind. The ship was so cold she cracked and popped all over when I set her down. But she stuck to the runways and came to a safe stop in spite of the side wind.

In speeding up the motor for the take off run, I advance the throttle gradually, taking about four seconds to push it clear ahead. This lever, usually called the "gun," is on the left side of the cockpit. It is held with the left hand while the right grasps the upright control stick which keeps the ship on an even keel sidewise and points the nose up or down. The rudder is governed by a foot bar or pedals on the floor. Newspaper stories are full of "he gave 'er the gun" and "he cut the gun." They give the impression that pilots jerk their motors on and off, racing them one minute and idling them the next. In emergencies, we do have to slap on the throttle. But whenever possible I save the engine by altering its speed gradually.

Enslow explains to the flying field mascot how rain entering the openings in the air speed indicator tube may make the dial readings go "haywire."

Pointing out the bank-and-turn indicator. Enslow calls it "the most important instrument on the board."

Adjusting the magnetic compass which guides the pilot through fog. The compass is easily compensated, or set at true north, by screws which vary the distance between magnets and needle. It is mounted on the airplane's fore-and-aft center line and away from iron and steel parts.

As a ship runs down the field for the take-off, the hand on the air-speed indicator advances. On the machines I now fly, it usually touches sixty before we climb into the air. Two little tubes, pointing ahead of the wing, regulate this instrument. One tube is open at the end, letting the air rush in. The other is closed and has tiny openings around it a little way back from the end. The rush of air past these openings causes a vacuum inside. The lower pressure of the vacuum and the push of the wind balance each other so the true air speed is shown on the dial.

If rain gets into the little openings, the indicator hand seems to go crazy. Once I was flying blind through fog and drizzle between Buffalo and New York. When I looked at the air-speed indicator, my eyes popped. It showed 300 miles an hour. Two hundred would tear the wings off the machine I was flying. I pulled back the stick gently. The ship began to climb. The hand advanced to 350. Then I knew the instrument had gone "haywire."

THE air-speed indicator shows only how fast a plane is going through the air. It does not indicate ground speed. The plane may be going sixty miles an hour through the air, but if it is bucking a forty-mile-an-hour gale, its ground speed is only twenty miles an hour. If it is flying with that gale its ground speed is a hundred miles an hour. So, on cross-country flights, I time myself over the first third of the journey to get an estimate of my ground speed to see if the fuel will hold out.

THE fastest I have ever flown with the wind was in Florida, when I was chased by the tail end of last year's hurricane. Below me, the eighty-mile-an-hour gale was tearing the roofs off houses as I shot past at 140 miles an hour. Yet, all the time, the indicator showed only sixty miles an hour—my speed through the air.

If a vote were taken among pilots, I imagine the instrument that would be selected as the most valuable would be the bank-and-turn indicator. It shows whether the wings are level when there is no horizon on which to "line them up." If one wing gets low in a fog, a ship may start side-slipping without the pilot realizing it. The climb indicator shows whether the ship is ascending, descending, or flying on a level.

As a machine climbs into the air, its height is recorded on the altimeter. This instrument is governed by a sensitive metal drum that expands and contracts with variations of atmospheric pressure. Before each flight, its hand must be set. If a ship sits all day or overnight, normal changes in the air pressure may cause the altimeter to indicate it is hundreds of feet in the air or an equally impossible distance underground.

A rise or fall of a hundred feet is scarcely noticeable on the average altimeter. Such instruments are not accurate enough for blind flying at low altitudes. Below eight or nine hundred feet is the danger zone. However, I once dove and looped a ship at 300 feet.

Only once have I pulled a crazier stunt in the air. That was when "Nick" Almgrim and I were barnstorming in Ohio. We had tagged along an old "Jenny" biplane that was born before the war. At last we got tired of having the flying tumbleweed around. So, at a Fourth of July celebration at a little town near Columbus, we gave everybody—including myself—the thrill of their lives. We packed the old bus with excelsior dipped in kerosene. I took it up a couple of thousand feet, touched a match to it, and crawled out with a parachute. Floating down, I had a grandstand seat to watch the flying bonfire.

I HAVE heard pilots tell of battling up 2,000 or 2,500 feet through fog without using their instruments. I'm from St. Louis. And that's in Missouri. They will have to show me. When my senses tell me one thing and the little dials on the instrument board tell me another, usually the dials are right. I've never doubted that after one experience I had flying in California.

The ship nosed into a big cloud at about 7,000 feet. The fog was so thick I could hardly see the propeller. The wings disappeared. The tail seemed to drop off. Sitting in the cockpit was like riding in a little bathtub a mile above the earth. When I dropped out of the cloud, I looked over the side of the ship to get my bearings from the ground below. What I saw was blue sky and clouds. I had been flying upside-down without knowing it! If I had remained long in that position, blood rushing to my head would have warned me. But bodily sensations are usually too slow to trust in a modern ship. Things happen quick in the air.

Enslow shows how he has steered a small plane by sticking his hand out one side of the cockpit. Above: Setting the altimeter before a flight. The instrument should be set at zero each day, Enslow says, otherwise changes in pressure will make its readings inaccurate.

Next to the instruments, probably the pilot's safest guide to the position of his ship is the seat of his pants. When the nose is up and he is climbing, he feels "heavy" in the seat. When it points down, he feels "light." When one wing drops, he feels heavier on the "uphill" side. When the ship skids on a turn, he feels himself tending to slide outward. After several hundred hours in the air, a flyer learns to respect these reports from the place where his trousers get shiny. Unless he develops "seat sense," a pilot won't get far.

Another thing learned from experience is to judge the steepness of glides by the humming of the ship's bracing wires. The steeper the glide, the higher the pitch of the sound. In a "graveyard glide," when the descent is so flat the ship is almost stalling, the humming is low and practically dies out altogether.

After a thousand hours in the air, a pilot observes things like that unconsciously. He develops abilities he didn't have before. I find that I can lean back in a cockpit, look up into a clear sky, and tell which way the wind is blowing. I can't explain it, but I "feel it in my bones." On cross-country trips, a knowledge of wind direction is necessary because a flyer must face into the wind in a forced landing. And on a cross-country flight there are no "socks," or wind cones, below as there are at an airfield.

Before a pilot develops the ability to "sense" the direction of the wind, there are signs he can look for on the ground. He can note which way smoke is carried from factory chimneys and locomotives, or can see how dust drifts away from country roads when an auto passes. Windmills point into the wind and clothes on the line indicate its direction. Ripples on water, grain, or grass show it also. If none of these can be observed, he can put the ship into a circle and keep it going like a merry-go-round, noting the direction in which it is carried by the action of the wind.

NOT long ago, I tested a little plane about the size of a mosquito, for a man down in North Carolina. The tiny ship got off the ground in the length of two telephone poles. It was so light that, when I stuck my hand out one side of the cockpit, the plane turned, just as a boat turns when an oar is held in the water on one side. By holding out a hand first on one side and then on the other, I cut figure eights without touching the rudder bar.

Such ships are too light. They are too tricky. Gusts upset them too easily. Only a pilot of long experience can guess what they are likely to do next. Remember that the next time you read of fleets of flivver planes being built weighing only a few hundred pounds apiece, for everyone to fly! I once ran into a whirlwind over Long Island with a light ship. It was flipped upside-down before I could catch my breath. To be safe and stable, I've found a ship should weigh at least 1,600 pounds.

The largest plane I have ever flown had a wing spread of 110 feet and weighed several tons. Big, heavy ships like the tri-motored Fords have a wheel at the top of the control stick. You turn the wheel to maintain sidewise balance and move the stick ahead and back to go up or down. It takes more force to move the controls on such planes and an ordinary stick might break off in heavy weather.

ON SHORT cross-country trips, I usually follow a highway or railroad. On long journeys or in blind flying in fog, I use a magnetic compass. The earth inductor compass, such as Lindbergh used on his flight across the Atlantic, costs too much for any

(Continued on page 145)

Soviet officials examining and appraising one of the greatest crystal collections in the world, the diamonds and other gems of Russian Crown Jewels taken from the former Czar.

Diamonds and Salt— Tiny Skyscrapers Built of Atoms

By E. E. FREE

THE most famous crystal in the world, the Kohinor diamond, ancient Indian gem of evil and murderous history now safely caged among the crown jewels of England, soon may lose its alluring supremacy. A few weeks ago before the meeting of the American Chemical Society at Minneapolis, Professor J. Willard Hershey, of McPherson College, showed a tiny seed of a gem greater still. His microscope crystal, the Professor said, is an artificial diamond. Soon he hopes to make larger ones; not to ruin the diamond market, but to aid a new and necessary science.

Even the famous Kohinor is not the largest diamond in the world. That honor belongs to the Cullinan stone, the cut fragments of which are also among the treasures of the British crown. Professor Hershey's diamond is perhaps the smallest in the world which anybody deems worth saving. Yet its value for the future may be enormous, for it promises better understanding of the remarkable things called crystals. Every diamond is a crystal, and every crystal is like a tiny skyscraper built of atoms, piled up in regular patterns like the framework of the building.

NO ONE can get far away from crystals. Every sand grain on the seashore is reasonably sure to be a tiny crystal. Each snowflake is a crystal's beautiful skeleton. The most useful crystals to man are perhaps those of table salt, without which no warm-blooded animal can maintain the necessary saltiness of its blood.

If by some magic every crystal in the world suddenly vanished, all buildings of brick, stone, or concrete would disappear; steel bridges would collapse into dust; jewelry would be robbed of its gems and the gold and platinum left behind would grow soft and spongy like bits of eggshell; nobody would have sugar for his coffee. For all these things are crystal forms of one kind or another.

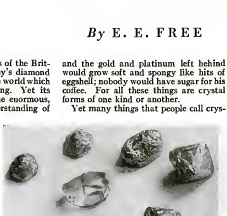
Yet many things that people call crystals would not vanish; "crystal glass," for example, for glass is not a crystal at all. Even the so-called crystal globes of psychic gazers are seldom real crystals.

DEFINITE knowledge of what crystals are has become possible only since the modern development of knowledge about atoms. In ancient days any bright, transparent stone was called a crystal. Professor W. J. Perry, the distinguished English anthropologist, says that search for these gleaming objects in streams and along the seashore probably was one of the first civilized activities of mankind; that it was the basis of the first world commerce and the spur to the first human migrations.

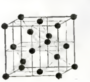
Nowadays the lure of crystals persists. Men and women sell their lives for bright jewels; rich collectors amass stores of beautiful crystalline minerals; scientific men delve into the insides of crystals, not seeking beauty for the eye but new facts about the universe.

The new atomic science of crystals is in many ways the reverse of the equally new science of colloid chemistry (P. S. M. Oct. '29, p. 42). In colloids, like egg white or glue, the atoms are arranged more or less at random, like a vast crowd of people strolling about in a field. In crystals, like diamonds or granulated sugar, the internal atoms are fixed in rigid patterns, like soldiers in perfect order at a parade. That is why crystals are likely to have bright, flat surfaces which brilliantly reflect the light, as do the facets of a diamond. The last rows of atoms on the outside of the crystal all stand in the same plane, like the men of a parading regiment or the flat front of a building. From such surfaces light waves shine back easily and perfectly. Some noncrystalline materials can be shiny, too, as polished glass is, but such things are usually without brilliance.

If there were a microscope powerful enough to look inside a crystal, like Professor Hershey's tiny diamond, it would be easy



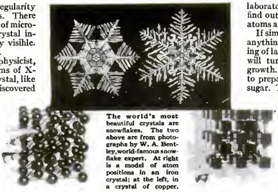
Rough diamonds (above) from the mine are cut and sliced by the machine at the right to bring out the crystals' hidden brilliance.



How the atoms of carbon are arranged in a diamond.

to see how important is this regularity of arrangement of the atoms. There actually exists, indeed, a kind of microscope able to make these crystal interiors evident if not literally visible. This instrument is the X-ray.

Eighteen years ago a Swiss physicist, Max Laue, sent narrow beams of X-rays through fragments of crystal, like a thin slice of diamond. He discovered that the X-rays were bent out of their paths in peculiar ways, now known to be related to the arrangements of the atoms inside the crystal. These observations were extended by Professor (now Sir William) Bragg in England, by Dr. Wheeler P. Davey in the United States, and by others. The result is that X-ray methods now make it possible to see, within reasonably wide limits, just how the atoms are arranged.



The world's most beautiful crystals are snowflakes. The two above are from photographs by W. A. Bentley, world-famous snowflake expert. At right is a model of atom positions in an iron crystal; at the left, in a crystal of copper.

THE first rule is regularity. The pattern of atoms in a crystal continually repeats itself. In a diamond all of the atoms are of the same kind, like the skyscraper's iron beams, for diamonds are the chemical element carbon in a pure state.

A convenient model of the atom pattern of a diamond is an ordinary cubical die, like those used in gambling games, but with its faces all marked alike with five black spots.

This would represent one unit cube of the diamond's atomic pattern. Each corner would be occupied by one carbon atom corresponding to one black spot on the die's face. At the center of each cube face would be another atom; this one making with the four corner atoms the five-point figure of each face. Inside the unit cube would be four other carbon atoms, arranged to form the figure which geometers call a tetrahedron.

Throughout the whole structure of a diamond this unit cube is repeated billions of times. It is the diamond's fundamental atomic pattern, called the "unit cube."

Lacking this definite structure, no assemblage of carbon atoms can be a diamond. The mineral called graphite, used to make lead pencils, is also composed of carbon. Often it is as pure as a diamond or purer. Yet it never resembles a diamond. Instead of being the hardest substance known, graphite is among the softest; instead of being transparent and incomparably brilliant, graphite is dull, black, and opaque. Yet the only difference between the two is in the arrangement of the atoms.

THERE is still dispute about the exact unit cube in which the carbon atoms of graphite are arranged to differ from the five-point arrangement of the diamond. This has been the problem of the would-be makers of artificial diamonds, and one which Professor Hershey now believes he has solved.

It is easy enough to prepare pure carbon and to make its atoms stick together. A little coke or charcoal, for example, may be dissolved in molten iron. When the iron cools some of this dissolved carbon freezes out, as sugar will freeze out of syrup when it gets too cold. But the carbon does not freeze out of molten iron as diamonds; it appears as graphite. The noteworthy thing about Professor Hershey's reported experiments is that he seems to have succeeded, by proper control of the surrounding conditions, in inducing the carbon atoms to arrange themselves in the diamond pattern.

IN SOUTH AFRICA, where most of the world's diamonds are found, these gems often occur in a curious, partly disintegrated rock called "blue ground." Geologists believe that millions of years ago this blue ground was in process of hardening deep in the earth; probably cooling for millions of years from a previous molten condition under a pressure of millions of tons to the square inch. Some unusual circumstance caused carbon atoms dissolved in the molten rock to gather together, it is believed, into the diamond pattern instead of the graphite pattern. Whether that circumstance was the extreme pressure or the very slow cooling or something else, no geologist nor crystallographer knows. If Professor Hershey really has turned the trick in his laboratory, it may now be possible to find out precisely what makes carbon atoms act in this way.

Crystals make radio broadcasters toe the line. Here H. W. Arlin of Westinghouse station KDKA is holding a tiny plate of quartz that keeps the wave length true.

If similarity to other crystals means anything, one necessity for the making of large diamond crystals probably will turn out to be extremely slow growth. One of the easiest substances to prepare in crystal form is ordinary sugar. The large, square-looking crystals of rock candy are the result. To make rock candy, the small sugar crystals are allowed to grow larger. If the candy is made very slowly, by allowing a sugar syrup to deposit its load of sugar molecules only a few each day and at a constant rate year by year, single sugar crystals can be grown as large as hen's eggs or as footballs. This is the secret that every scientist wishes he knew about less complacent crystals, like diamonds.

That the secret of making substances form larger crystals than usual can be learned is proved by recent successes in the study of metals. In examining the properties of metals important in electrical engineering, like tungsten for the filaments of electric lamps, it became desirable to examine metal crystals larger than the ones observed under a microscope. So new methods were devised to "grow" large metal crystals, like the large sugar crystals of rock candy. Rods of copper, iron, or other metals were put in electric furnaces and kept at exactly the right temperatures for weeks or months. Slowly the atoms of copper, for example, rearranged themselves completely into the repeated unit structure of a copper crystal. Single crystals of these metals inches long have been produced thus and subjected to electrical and mechanical study.

THE unit cubes which represent the atomic patterns in copper, iron, and other metals are not exactly the same, of course, as the five-point dice which form those of a diamond crystal. Copper crystals have, however, an arrangement not very different. The five-point dice faces are still there but there are no extra atoms inside. Crystals of pure iron appear to have a still simpler unit cube; like a die with four points on each of its faces instead of the diamond's five. There is an extra iron atom, too, at the cube's center.

Other elements and compounds show still other atom patterns. Hundreds of different patterns are now reasonably well known. Nearly all have been worked out by the X-ray, the chief tool of crystal explorers. Out of such unit patterns and their combinations, all the myriads of crystal forms of minerals and chemical compounds are believed to be built up, as an artist might construct millions of separate designs out of simpler units like cubes or circles or triangles.

One of the best known of all crystals, and perhaps the most useful scientifically as a yardstick to measure sizes throughout the whole crystalline world, is that

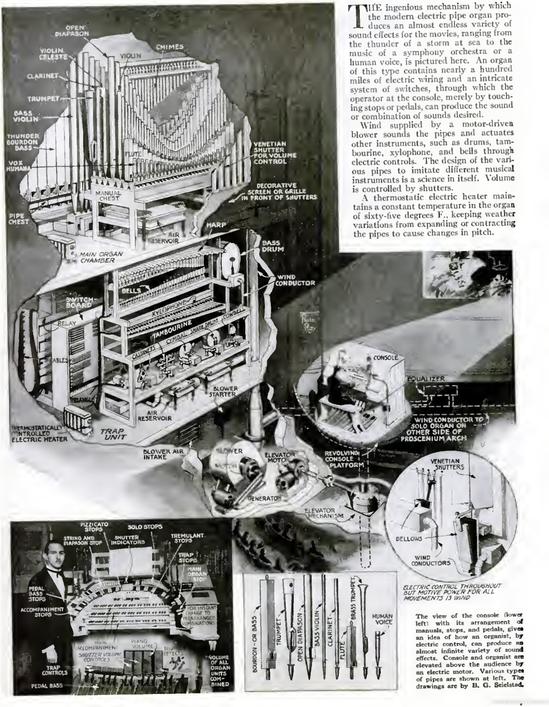
(Continued on page 140)

A Box of Sounds for the Movies

THE ingenious mechanism by which the modern electric pipe organ produces an almost endless variety of sound effects for the movies, ranging from the thunder of a storm at sea to the music of a symphony orchestra or a human voice, is pictured here. An organ of this type contains nearly a hundred miles of electric wiring and an intricate system of switches, through which the operator at the console, merely by touching stops or pedals, can produce the sound or combination of sounds desired.

Wind supplied by a motor-driven blower sounds the pipes and actuates other instruments, such as drums, tambourine, xylophone, and bells through electric controls. The design of the various pipes to imitate different musical instruments is a science in itself. Volume is controlled by shutters.

A thermostatic electric heater maintains a constant temperature in the organ of sixty-five degrees F., keeping weather variations from expanding or contracting the pipes to cause changes in pitch.



ELECTRIC CONTROL THROUGHOUT BUT MOTIVE POWER FOR ALL MOVEMENTS IS WIND

The view of the console (lower left) with its arrangement of manuals, stops, and pedals, gives an idea of how an organist, by electric control, can produce an almost infinite variety of sound effects. Console and organist are elevated above the audience by an electric motor. Various types of pipes are shown at left. The drawings are by B. G. Seielstad.

Back of the Month's News

High cirrus clouds photographed from Mount Wilson, California, by Ferdinand Ellerman. These clouds are composed of tiny ice crystals. Scientists are making new classifications of cloud formations and movements to aid weather forecasting.

By

KARL VOOGHT

THERE is a story of a medieval prisoner who could see from his cell window nothing but a patch of sky. So he became, as the years dragged on, an expert in clouds and pronounced the weather forecasts for the neighborhood. The tale is scientifically plausible. Weather instruments like thermometers and wind measures, the stand-bys of modern weather forecasting, tell only of the bottom of the air ocean surrounding the earth. Clouds disclose, or may disclose, what is going on in this air ocean a mile or two above the ground.

Among French weather experts much use is made of cloud shapes and cloud movements in weather forecasting. More use might be made of them everywhere were there satisfactory classifications of types of clouds. That is one reason why an international committee of weather experts is now at work on new cloud classifications and on the preparation of a new International Cloud Atlas in which typical clouds will be illustrated.

Literally hundreds of different names have been proposed for types and sub-types of clouds. Amateur weather observers, confronted by this complexity, commonly abandon cloud studies altogether. The difficulty seems to be that clouds, like most other natural objects, refuse to fit perfectly into any series of artificial pigeonholes. Always there are intermediate cloud types for which the classification has no place.

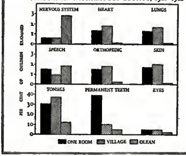
Three chief types include, however, most of the main cloud forms. First are the cumulus clouds, Latin for "heap," which pile up in mountainlike masses in summer skies. Second are the stratus clouds, Latin for "sheet" or "layer," which cover the sky more or less completely at a fairly uniform level. Third, and most beautiful of all, are the cirrus clouds, named from the Latin word for "curl." These cirrus clouds, usually much higher above the ground than other types, are not composed of water droplets but of tiny crystals of ice.

Before the days of modern weather science, when each farmer or ship's captain had to be his own weather prophet, cloud forms and cloud movements played a large role in weather lore. It is probably a loss to weather science that they have been displaced. If cloud classification can be simplified so that everyone can understand it, perhaps the clouds will come back to their own as indicators of weather probabilities.

Power by Radio Possible?

THE dream of distributing electric power by radio is almost as persistent a will-o'-the-wisp as that of perpetual motion. It has, perhaps, somewhat more chance of fulfillment, for no fatal obstacle of physical theory stands in its way, as the principle of the conservation of energy stands in the way of producing power for nothing. Yet the incidental difficulties of radio power transmission seem almost insuperable.

Latest of speculators concerning radio power possibilities is Dr. Jacques Risler, a Parisian physicist already known for researches in the use of ultra-violet rays and other invisible radiations. In the use of radio waves of extremely high frequency and low losses in the atmosphere, Dr. Risler sees at least a possibility of useful power transmission.



This comparison of defects among children in one-room rural schools, in village schools, and in city schools of Olean, N. Y., shows that the city children suffer more from nervous disorders, but less from other defects.

The difficulty with radio power, as was perceived more than two years ago by Dr. Phillips Thomas, the foremost American experimenter in this field, is not so much the loss of power suffered when radio waves pass through the atmosphere as it is the invincible tendency of these waves to spread outward and waste their energy, as ripples spread on the surface of a quiet pond. Were it possible to condense radio energy into a definite beam, as can be done with the light rays of a searchlight, greater possibilities would be apparent. To some extent, as Dr. Thomas proved, this beamlike condensation can be managed, but not sufficiently thus far to threaten the present systems of distributing power through wires.

With rare exceptions, energy has an incurable habit of spreading itself as thin as possible, like water spilled on the floor or like a handful of gas atoms let loose in a vacuum. Most of man's accomplishments in handling energy, like those, for example, which are responsible for electrical engineering, have consisted in some device to keep the energy in one place until it is used. The energy of steam is kept inside the boiler by the steel shell. The energy of electricity is kept inside the wires by a covering of insulating material. Dr. Risler's difficulty is that there is nothing to keep radio energy inside the path assigned to it.

Nervous Cities

CITIES are dangerous weapons which mankind has by no means learned to control, some philosophers claim. They contend that the city man, for all his advantage in schools, social contacts, and in earning a living, will be less healthy, happy, and long-lived than his country cousin. Little actual evidence of these familiar contentions has ever been obtained, but

Weighing one of the children examined in the health survey which revealed comparative defects in city and country children of Cattaraugus County, N. Y.

one hit came to light recently in the work of the Milbank Memorial Fund of New York City.

In Cattaraugus County of New York State, demonstrators financed by this Fund have conducted for some years health inquiries and surveys. Cattaraugus County includes the small city of Olean. The investigations show that children from the country districts of the County, as contrasted with children in Olean, suffer substantially greater percentages of various bodily defects. Imperfections of heart, lungs, skeleton, skin, teeth, and eyes were found to be much more prevalent among the country children than in the city children, but precisely the reverse is true for defects of the nervous system. Children in Olean disclosed more than four times as many such nervous difficulties, on the average, as were found in children from the country.

This finding indicates that city life, even in so small a city as Olean, puts upon the nervous system of the average child a greater strain than is encountered in the country. Many reasons might be advanced for this: late hours, too much excitement, overcrowding, city noise, and others. Only by continued, accurate investigation will the truth be disclosed.

Meanwhile, physicians and psychologists agree that the percentage of mental disease and mental deficiency in the United States is increasing, especially in cities. Is the modern city, perhaps, too nerve-racking an institution for man's present mental and nervous equipment?

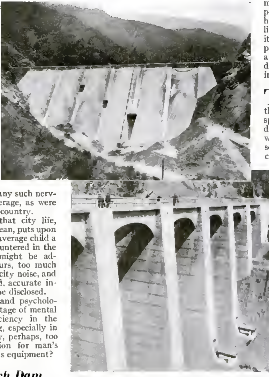
The Newest Arch Dam

THE prosperity of Los Angeles, Calif., depends not on tourists or on Hollywood movie stars, but on hydraulic engineering. Of all large American cities, Los Angeles has the smallest natural water supply. During most of the year the so-called Los Angeles River is a dry gully. Long ago the growing city exhausted all possible resources of wells drilled into the plain on which it stands. It has been necessary for the city engineers to go far into the desert and bring down the Owens River and to catch and conserve every gallon of available rain water in the city's neighboring hills. Now, by means of the Boulder Canyon Dam, it is proposed to tap a portion of the great Colorado River lying to the east.

Among many smaller engineering works closer to the city is the Dalton Dam, just completed near Glendora. It will provide irrigation water, flood protection, and emergency drinking supplies for some of the southern California territory. With a capacity a little short of 400,000,000 gallons, the Dalton Dam is not remarkable for size. The Roosevelt Dam in Arizona, for example, holds over a thousand times more water. The Elephant Butte Dam in New Mexico will hold two thousand times more. The engineering interest of the Dalton Dam is in its construction, for it employs the relatively new type of the multiple arch.

Dams may be classified into three types. First are those held down merely by weight, like the old-fashioned earth dams in which ordinary soil or broken rock is dumped across a valley to make an artificial hill. Most stone and concrete dams are constructed similarly, the structure being merely a plug of solid material laid down across the valley and fitted closely against the underlying rocks.

A more modern type is an anchored dam, in which the wall of concrete or stone is sunk into the rocks at the sides and bottom of the valley, so that the dam acts almost like a bolted door or like the gates of a canal lock. Still more modern is the arch dam, in which arched structures of suitable shape are faced upstream against the water pressure, so that this pressure wedges the dam into the valley, like a properly-shaped stone hammered into a crack. The advantage of arch dams, whether single or multiple, is that less concrete needs to be used for equal stability and strength.



The new Dalton Dam near Glendora, Calif., which will provide irrigation, flood protection, and emergency drinking water for sections of southern California. The upper view shows its multiple arch construction. Huge concrete abutments which reinforce the dam are shown in the lower photo.

Stars Too Hot to See

DR. LOUIS BERMAN, of Lick Observatory, Mount Hamilton, Calif., has discovered some of the queerest stars in the universe—stars that are too hot to see. The hotter any object is, the more violet and ultra-violet light it emits in proportion to the green and red. For example, "white" or "blue-hot" iron is at a much higher temperature than metal just glowing a cherry red. It is possible to conceive of an object so hot that most of its radiated energy lies in the ultra-violet, in which case it may be impossible to see it or photograph it. Dr. Berman's stars are of this variety, and his method of detecting their existence is ingenious indeed.

THERE are certain objects in the sky known to astronomers as the "planetary nebulae." These are spheres of luminous gas, such as hydrogen, helium, and oxygen. Studies with the spectroscope show that the source of luminosity is a star at the center of each. That these stars are extremely hot is evidenced by the fact that they can be seen visually only in telescopes of highest power, whereas their near-ultra-violet light, although unperceivable to the eye, is so intense that the star is always conspicuous on a photographic plate.

Just as a radio receiver is capable of absorbing ether waves vibrating too fast to be heard and transforming them into audible sound, the atoms that form the nebula are able to pick up the rapidly vibrating ultra-violet energy radiated by the central star and re-emit it as light that can be seen or photographed.

The hotter the star the more abundant is the invisible radiation, and, consequently, the brighter the nebula. In some of the planetary nebulae no central star has been seen, which, of course, raises the question of what makes them shine. Dr. Berman discovered that the atoms composing this variety of nebula are unusually disturbed, and has suggested that central stars actually exist therein but that by far the greatest proportion of radiation lies in the extreme ultra-violet. In other words, the stars are literally too hot to be seen.

Dr. Berman's study indicates that temperatures of 35,000 to 50,000 degrees centigrade for planetary nuclei are not uncommon and that still higher values are indicated for many. Compare these figures with the sun's temperature —6,000 degrees. Apparently the planetary nuclei are the hottest objects yet observed on earth or in the heavens.

Universal Yardsticks

PHYSICISTS have dreamed for years of being able to measure everything in the universe, such as atoms, light, and the gravitation of the planets, in terms of a few universal constants, more fundamental than such arbitrary units as feet or gallons. The speed of light in a vacuum is one of these fundamentals, for all tests indicate that this speed is always and everywhere the same.

Months ago Professor Raymond T. Birge, of the University of California, undertook a critical summary of all available information concerning the exact values of these physical constants of Nature. The results have now been published by the American Physical Society, together with reprints of the constants themselves on sheets of cardboard, so that working physicists can tack them up for laboratory guides as business men use calendars. There are 103 units and ratios in Professor Birge's list, but many of these, admittedly, are convenient figures for making calculations rather than fundamental ones.

Ten of Professor Birge's figures are of first importance. Two are atomic weights as used by the chemist—the weight of the oxygen atom and that of the hydrogen atom. These provide a basis for atomic weights of other elements. Another fundamental is the freezing point of water or, what is the same thing, the melting point of ice. This fixes the most important fundamental of the scale for thermometers.

ANOTHER vital constant is the so-called mechanical equivalent of heat; that is, the precise amount of heat set free when a certain quantity of mechanical energy is used up, for example, in friction. Two electrical constants are included among the ten. One is the Faraday constant, which represents the amount of electricity carried by a definite number of atoms in an electrochemical reaction, such as electroplating. The second is the electric charge of one electron, as determined by the classic investigations of Professor R. A. Millikan. Still another fundamental is the volume of a perfect gas, since this lies at the root of all calculations of atmospheric pressure, steam boiler behavior, refrigerating machinery, and hundreds of other items of technical equipment.

Among the three remaining constants on the list is that of the velocity of light, of which the most accurate measurement —186,284 miles a second—was obtained in experiments by Dr. Albert A. Michelson, distinguished physicist of the University of Chicago (P. S. M., Aug. '29, p. 48). Dr. Michelson now is working with new apparatus to obtain a figure even more exact. Another is the constant of gravitation (about the inner meaning of which science knows virtually nothing). Most important of all, perhaps, is the mysterious "Planck constant" which shows up in scores of physical phenomena, from the behavior of atoms to the heat radiated from a cooling body. No one knows what this "Planck constant" represents, but it is so commonly discovered when the analysis of physical facts is pushed as far as possible that physicists suspect it of having some very important meaning concerning the inmost structure of the universe.

Dr. Albert A. Michelson, distinguished physicist of the University of Chicago, with the new transmitting apparatus he is using in experiments to obtain a more exact measurement of the velocity of light. His measurements in previous experiments placed the figure at 186,284 miles a second.

A busy day for the tattoo artist. Most of the designs, samples of which are seen on the wall, have historical, patriotic, or other symbolic meanings. Many have the flavor of the sea.

History in Tattoos

WHAT are regarded as important fragments of ancient Egyptian history have been recovered from living Egyptian skins. For some years a distinguished British anthropologist, Miss Winifred S. Blackman, has been studying existing races of man in Egypt and comparing these with their ancestors. Many modern Egyptians carry on their faces or bodies tattooed designs. One day it occurred to Miss Blackman to study what these designs are. To everyone's surprise they turned out to be very ancient. Some have been identified as going back more than 3,000 years, to the times of Joseph and Moses. Others have been traced to ancient Babylonia, to Persia in the days of Darius the Great, and to other ancient lands.

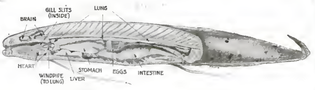
Miss Blackman has made a collection of more than one hundred designs used by modern tattoo artists in Egypt. These designs will be preserved and studied as carefully as though they were actual documents from ages long past. From such study, it is believed, clues to obscure facts of ancient history may emerge.

The art of tattooing probably is, with one exception, the oldest in the world. The exception is the use of the paint pot and paint brush with which ancient peoples were accustomed to decorate their forms. In the beginning, all of these painted and tattooed designs probably were important symbols. They marked the positions of the decorated individuals in definite tribes, clans, or religious sects. The famous Moslem traveler, Ibn Battuta, who visited Egypt in the fourteenth century, describes the practice governors of Egyptian cities had of stamping on the arms of visitors in indelible ink a mark indicating freedom to leave town, just as modern customs officers stick little printed seals to travelers' baggage. Tattooing, it is probable, was often a symbol of the same type, though more permanent.

Modern tattooing, if studied carefully, might disclose equally interesting facts. Most of the tattooed designs still in use have obvious historical, patriotic, or other symbolic meanings. Even when worked into the skins of peoples who are not sailors, these modern designs often carry the flavor of the sea. Sea serpents and sailing ships decorate the chest of many a man who has never seen the sea.

A Fish with Lungs

THE evolution of life on earth was marked by two great turning points—the invention of the backbone and the coming out of ocean life onto the land. Evidence of both these events survives in modern creatures—"living fossils" like



Courtesy The American Weekly

Anatomy of the lung fish, a surviving example of evolution from water breathing to air breathing. When the water is foul the fish goes to the surface and gulps pure air into its primitive lungs.

the remarkable lizards of Australia which resemble miniature copies of the ancient dinosaurs. Geologists have always regretted, however, that no actual fossils of the first backbones, or of the first air-breathing fishes, have been found.

One reason for this lack, at least in the case of the first air-breathers, was suggested recently by Professor D. M. S. Watson, of the University of London. It is probable, he said, that the first transition of ocean life to the land took place around the shores of a continent since sunk beneath the sea. Surviving creatures which show this change from water breathing to air breathing—the so-called lung fishes of the zoologists—are almost precisely the same on the two sides of the South Atlantic Ocean, in Africa and in South America. This fact, Professor Watson said, strongly suggests that the first evolution of these creatures so important for life's history may have occurred on a continent believed to have stood where the South Atlantic now rolls.

Much geologic evidence points to the existence, millions of years ago, of this hypothetical South Atlantic continent. It has even been christened Gondwanaland. Many other fossils and living creatures, when studied on the two sides of the Atlantic, indicate the same transition as do the lung fishes.

Lung fishes of the South American swamps do not live in the air, but a curious handicap of their homes forces them to breathe it. In the swamps there are seasons at which most of the vegetation dies and decays, making the water exceedingly foul. No oxygen is left in this water for fish gills to absorb. Accordingly, the lung fish go to the surface and gulp down pure air. While they do not actually have lungs, spongy sacs connected with their throats and food canals receive this air and absorb its oxygen into the blood.

Even the human lung, physiologists know, is simply an outgrowth from the throat tube originally used exclusively for swallowing food. Thus the lung fish really has the same air-breathing mechanism as human beings but in a more primitive form.

Studying the Apes

OF GREAT interest to psychology is the recent statement by President Angell of Yale University that the University proposes an ape experiment station in Florida. This will be a part of the new Institute of Human Relations; which is quite fitting, although perhaps not exactly as President Angell intended, since of all human "relations" the apes are the closest and the most interesting

Some years ago in Florida, Professor Robert M. Yerkes, of Yale, studied the young female gorilla named "Congo." At New Haven, also, Professor Yerkes maintains a colony of apes. The New Haven climate, however, is not friendly to these delicate animals. Even in Florida it proved impossible to keep Congo alive. In the proposed new Florida station every suitable facility will be provided for the health and happiness of these animals, for so like human beings are they that happiness seems just as important to their survival as does bodily health.

The importance of all this to the science of psychology is that it begins to dig around psychology's roots. Not long ago Professor A. L. Kroeber, of the University of California, reviewed the mental accomplishments of apes and men. He concluded that the germs of human inventiveness, of the use of tools, the idea of competition, and habits of dress and adornment, all were discoverable in living apes like the gorilla and the chimpanzee. Even the beginnings of the religious impulse he found to be pre-human.

One thing that apes do not have seems to be speech. This is not because they lack the vocal mechanism, says Professor Yerkes, but because some mental deficiency prevents the image-forming habit which seems necessary to real language. Of everything that makes a man the apes have something, but not enough.

"As our knowledge and understanding of anthropoid life increases," writes Professor Yerkes, "so also our thankfulness that we are men."

Testing samples of steel with new magnetic apparatus developed in the Westinghouse Research Laboratory. Manganese is essential for modern steel.

The laugh of a chimpanzee. So much like human beings are these apes that happiness seems just as important to their survival as does bodily health.

"Medicine" for Steel

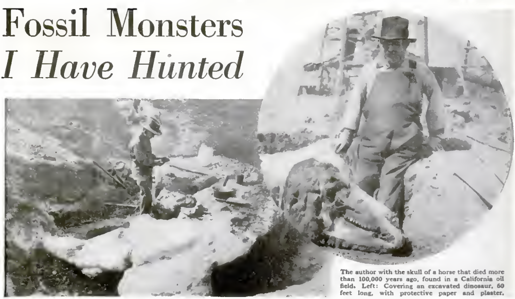
RECENT political discussions of the proposed tariff duty on manganese probably will result in increased public acquaintance with this important metal which has commanded less interest than it deserves. *(Continued on page 147)*

How Much Do You Know About Eyeglasses?

TEST your knowledge with these questions, chosen from hundreds asked by our readers. Answers are on page 153.

1. **Why do people have to wear eyeglasses?**
2. **What is astigmatism?**
3. **Why does an elderly person require two pairs of glasses, one for distance and one for reading?**
4. **What is nearsightedness?**
5. **What are toric lenses and why are they any better than the plain flat lenses?**
6. **How many hours a day can a person use the eyes without causing eyestrain?**
7. **What is the best kind of reading light for a person who has to use glasses?**
8. **What is the matter with eyes that are farsighted?**
9. **Is there any way to cure defective vision?**
10. **Is a reading glass as good for reading fine type as magnifying eyeglasses?**

Fossil Monsters *I Have Hunted*



The author with the skull of a horse that died more than 100,000 years ago, found in a California oil field. Left: Covering an excavated dinosaur, 60 feet long, with protective paper and plaster.

Indians were still roaming the western plains when the author of this article began his search for the remains of ancient life in America. In sixty years as a fossil hunter he has unearthed more than three hundred prehistoric reptiles, birds, mammals, and fishes. Many of the dinosaur monsters of the museums are trophies of his pick, chisel, and dynamite. Now, at the age of eighty, he tells the unique story of his adventures and discoveries.

By CHARLES H. STERNBERG

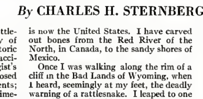
THE warning whir-r-r of a rattlesnake led to the discovery of bones of the largest prehistoric creature ever found; the accidental stroke of a geologist's pick into a slab of sandstone disclosed remains of the ancestor of all sea serpents; and the glint of the sun's rays on a time-polished tooth revealed one of the first of the several forms of the horse. The skeletons of monster fishes, lizards, birds, and mammals of ages past are hidden in the rocks like gold, and the work of hunting them is always adventurous, often dangerous. The fossil hunter is forever lured by the possibility that in the next cliff he will find the skeleton of some monster never before seen.

For more than sixty years of my eighty years of life I have been a hunter of big game that lived on earth three to five million years ago. I have dug up and preserved fossil life, from tiny gastropods less than an inch in diameter to dinosaurs seventy feet or more in length. I have found, entombed in stone, a sea-dwelling reptile, ancestor to whatever sea serpents may have lived since. I have discovered skeletons that belonged to toothed birds of giant size, and to the various forms of ancient horse which roamed what is now the United States. I have carved out bones from the Red River of the North, in Canada, to the sandy shores of Mexico.

Once I was walking along the rim of a cliff in the Bad Lands of Wyoming, when I heard, seemingly at my feet, the deadly warning of a rattlesnake. I leaped to one side, slipped, fell, slid over the edge of the crag, and came to a sudden stop sitting down on what apparently was a brown boulder, about ten feet from the top. The "boulder" was the shoulder bone of the largest dinosaur ever unearthed. It was nearly eighty feet long, sixteen feet high at the shoulders, and probably weighed fifty tons or more. Had it not been for the snake on the edge of the cliff, that monster reptile, probably five million years old, would have remained undiscovered.

SUCH unexpected twists of fate make fossil hunting one of the most fascinating games in the world. Searching for prehistoric shells and other marine life on the one-time shore of a great ocean in Kansas, I dropped the geologist's pick I was carrying and the sharp point accidentally struck a slab of sandstone, flaking off a chip a foot long and half as wide. Beneath, dark brown against the pale yellow sandstone, was the tooth-filled snout of a huge fish. Careful excavation revealed it to be a *Portheus molossus*, a prehistoric fish fourteen feet long, probably able to destroy any shark alive today.

But finding prehistoric specimens is not all luck. The hunter must follow certain definite rules and, in the end, the man who looks over the most square feet of ground makes the most important discoveries. The unexpected finds, however, are the ones that stick in a fossil-hunter's memory after the methodical labor is forgotten.



Skull of a duck-billed dinosaur, found in Wyoming, ready for mounting. The creature, 30 to 45 feet long and 15 to 20 feet tall, cut off branches with its beak and ground them with great molars.

An expert replacing lost bones in the huge skull of a dinosaur. The original bone projects at the right, and at the left is the rebuilt bone.

The first rule to guide his search is the fact that the fossils are found only in outcroppings of sedimentary rock, such as sandstone and limestone, which were laid down in the ages in which the hunted specimens lived. The best specimens usually are discovered in sandstone, for the reason that these formations represent ancient shore conditions where life was plentiful and where the animals were buried rapidly. The United States Geological Survey has covered virtually the whole country and its reports show just where outcroppings of the different strata of rock can be found.

THE best hunting ground for fossils is in western states where sedimentary rocks are exposed and there is no grass. In his search, the hunter decides what sort of specimens he will look for and then studies the Geological Survey reports to see where exposed rocks representing the age in which those specimens lived can be found. He decides upon one region and establishes a central camp from which he searches methodically.

Sometimes the specimen he seeks is discovered right at the door of his tent, as was the case in one of my expeditions to Canada. Walled in by rain in the valley of a river in Alberta, I bemoaned the fate which prevented me from searching for fossil duck-bills, belonging to the family of the huge herbivorous dinosaurs. Yet, after the rain had passed and I stepped from my tent, I saw on the face of a nearby cliff, clear cut as with a knife, the complete and almost perfect skeleton of the great and terrible *Tyrannosaurus rex*, king of all carnivorous dinosaurs. The rain had washed earth and some stone from the front of this wall, revealing the fifty-foot lizard, the terror of the jungles of its day on earth.

Though, in general, paleontologists know about where to look for fossilized remains, every now and then some more adventurous fossil hunter finds a new hecatomb of prehistoric monsters, and perpetuates his name and fame with some new species. For this work, financial remuneration is not large, the best price paid for a well-preserved dinosaur skeleton being about $2,000, while the cost of getting it out is considerable. But there is as much adventure hunting fossils as there is in hunting living big game. The present animal life of the world is comparatively well known, while always, just ahead of the fossil hunter, is the probability of discovering some hitherto unknown monster.

Using a power drill to place a steel frame in the skull of a dinosaur preparatory to mounting the skeleton.

When a fossil is found the work of the discoverer has just begun. More fragile than glass, buried in adamantine stone through which only a chisel can trace them, the bones, millions of years old, must be extricated as gently as a veteran smoker handles a meerschaum pipe. By patient chipping, frequently requiring weeks, the fossil hunter first traces the form of the buried creature through the cliff or ledge. This is a delicate task, the stone being removed in tiny chips and flakes no larger than a thumb-nail until the skeleton is etched in relief against the stone. Then, some three feet distance from the outermost bones, the rock is cut from the hillside or canyon wall. The cutting is driven beneath until the great natural sarcophagus is free except for small tongues of stone which hold it from slipping.

Sometimes dynamite or gunpowder is used in blasting away the rock. Under expert handling, the charges may be shot within a foot of the fragile bones without injuring them. Where the material surrounding the skeleton is broken sandstone, a coating of shellac is spread over the surface to keep the rock from disintegrating while the work is being done.

IF THE bones are large, as in the case of the duck-billed *Trachodon*, the stone is chipped away in some instances until the external surfaces of all the bones are revealed. No attempt is made to remove the stone from the interior of the body cavities, for as soon as these skeletons are released from their protective covering they break at a touch, and often crumble to fine dust at a breath of wind.

A large skeleton is cut into sections weighing from 1,000 to 4,000 pounds each. A skeleton of a *Triceratops*, a three-horned dinosaur, may be divided into three or four sections, separated at points where bones join, so that when removed from the stone at the museum, the skeleton may be fitted together accurately.

EACH of the sections is covered with dampened rice paper, after which strips of coarse burlap, dipped in flour paste or plaster of Paris, are wrapped over the whole. These strips, three or four inches wide and from one to three feet long, are laid first in one direction and then in another to hold firmly and protect the skeleton during transportation to the museum.

The protected sections first are hauled to the main camp of the fossil hunter, where they are boxed in heavy, specially-designed containers. Railroad men handle these cases like glassware, and when they are finally rolled into the museum workshops, whether they be in New York, Paris, or Berlin, the specimens are unpacked by highly-skilled workmen who place the great stone blocks in the order in which they are to be worked by the preparators.

One of the most difficult jobs of extracting a skeleton from stone that I ever encountered was tackled in Converse County, Wyoming, where, by a curious accident, I discovered an almost perfect specimen (Continued on page 139)

Courtesy American Museum of Natural History

A museum restoration of the terrible *Brontosaurus*, one of the enormous reptiles which lived in the western part of the United States thousands of years ago. It was 25 feet long and 12 feet tall.

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Trivialities That Count

TO THOSE not aware of the revolution that recently has been upsetting classical psychology, some of the goings-on of scientists who attended the International Psychological Congress at Yale University, described elsewhere in this issue, may seem trivial. What possible good can it be, for example, to know that an ape can be taught the difference between a blue and a red colored disk? Or that the drug bashish strangely distorts a man's perception of an object's size?

Perhaps one of the physical sciences furnishes an answer. There was a time when chemists—then called alchemists—imagined that fire, water, earth, and air were the elements of which all things were made. The ascent from that to modern chemistry has been the direct result of slow, patient accumulation of seemingly trivial facts. The minor but acute observation that iron grew heavier instead of lighter when it rusted was enough to overthrow the old theory of "phlogiston"—mythical gas supposed to rush from burning objects—and to lead to the discovery of oxygen.

Psychology, baby of the sciences, has learned a trick or two from its older brothers. Its experimenters today, led by the new group of "behaviorists," look with lessening favor upon the elegant theories and assumptions of a generation ago. Instead of hypotheses they want facts. Thus a leader of the behaviorists is reported to have dropped his own baby repeatedly upon a bed from varying heights to study its actions.

No human or animal mannerism is too trivial for a modern psychologist to observe. In some minor action, in the patient accumulation of many data of minor actions, may be found the key to a long-standing riddle of human thought.

Soil Erosion Alarmists

LIKE most propagandists, professional viewers with alarm over the so-called menace of soil erosion are weakening their case by overstatement. More than one hundred billion pounds of plant food are lost to the country's soils every year by being washed away, says a recent announcement. The estimate is almost certainly far too large, but even were it exact the meaning would be less than is implied. This is like making the unquestionably true statement that more than ten billion cubic feet of air is ruined every year in the United States by being breathed. What of it? The real point is how much air is left.

So with the soil. Extremely conservative calculations show the United States to possess at least three hundred trillion pounds of soil-contained plant food materials. Of that total the already overlarge estimates of losses by soil erosion equal less than four hundredths of one percent, which fact explodes the alarmist calculations like a pricked balloon.

The rapidity with which soil is renewed by natural processes, the raw materials of rock being ground up by things like frost and earthworms and digested chemically through aid of soil, moisture, and weather, is still scientifically debatable. Perhaps the country's soils are being depleted by wash or cropping faster than they are being restored; perhaps not. Nobody knows. Nor does anybody know with enough assurance to make calculations whether the chemical constituents of the soil will be necessary at all a century hence. It has been seriously suggested by competent engineers that agriculture might do better to use naturally foodless soils, like quartz sand, and to supply the needed food materials artificially.

The washing away of soil may be a serious matter, undeniably, for the individual farmer whose fields are being damaged. There are a few counties, mostly in the southern states, where gullying and hillside scars amount to a community problem. All this is not hard to stop. The only necessities are careful and competent farmers, plus a little public education. But this public education is precisely the thing which is not aided, in the long run, by failure to stick to the exact truth.

Forward in Building

RECENT studies of city noises have shown that the familiar rat-tat-tat of pneumatic hammers that accompanies the building of a skyscraper is one of the most nerve-racking in existence. It is all the more objectionable because it is utterly needless.

An article in this issue tells of the increasing use of silent welding methods to erect safe steel buildings. More than forty-five cities already have modified their building codes to take advantage of this modern method. Others cling to their antiquated codes. New York City is among the latter, because when welding was in its infancy fourteen years ago the city officials drafted a code that read, "Beams resting upon girders shall be securely riveted or bolted to the same," and no one since has dared to modify it despite almost daily complaints to the Health Department about noise.

All this is singularly reminiscent of the outcries at the close of the last century, when in some quarters it was suggested that pins might not be the best way to fasten trusses together. It took a long time to convince the old-timers that rivets made trusses stiffer than pins. How long will it be before some of our cities awaken to the fact that another step forward has been made?

They Are Saying—

"After eighty-six years in many lands and among nearly all races I came across only one woman who stammered."—Major T. H. Hill, British surgeon.

"We carefully dye our clothes so they won't show the dirt and count ourselves clean because shirt and collar are fresh from the laundry."—Dr. C. W. Saleeby, Chairman of the Sunlight League.

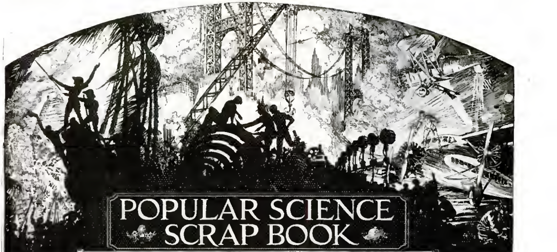
"Sun spots caused the remarkably warm and dry fall weather in Western Europe this year."—Henri Memery, director of Talence Observatory, France.

"In former times, competition and war were necessary for the securing of food, which could only be obtained by the victors. Now, owing to the mastery of natural forces which science is beginning to give, there would be more comfort and happiness for all if all devoted themselves to the conquest of Nature rather than of each other."—Bertrand Russell, English philosopher.

"Because of modern smoke conditions, our cities are literally going through the dark ages."—Dr. Shirley W. Wynne, Health Commissioner, New York City.

"Posture is an almost infallible index to character. A person's salient characteristics can be discerned from the way he holds himself.— Professor William H. Blake, Teachers College, Columbia University.

"History proves that the nation that first takes hold and makes best use of any new development in transportation further advances its prosperity and importance."—Paul W. Litchfield, President, Goodyear Tire and Rubber Company.



POPULAR SCIENCE SCRAP BOOK

On the following pages are presented a month's record of invention and brief bits about the new, interesting, and unusual things people are doing in all parts of the world.

Suction Pipe "Stevedores" Unload Copra Cargoes

At the waterfront in the harbor of Portland, Ore., stands one of the largest plants in the United States for the extraction of oil from copra, the dried meat of coconuts. Large steel freighters tie up at its dock, and their valuable cargoes of copra from Manila, Cebu, or Singapore are unloaded in the shortest possible time through an ingenious system of pneumatic tubes which operate like a vacuum cleaner.

When the vessel docks, the receiving ends of two ten-inch pliable steel tubes are dropped into the hold where some 1,500 tons of dried coconut meat have been loosely dumped. Electrically driven machinery in an iron building on the dock is set at work, and the cargo is sucked up at the rate of about forty tons an hour and blown by escaping air to storage tanks in the building.

From there it goes by worm conveyors to the first set of grinders, which break it into bits that look like barley, and is dropped into a jacketed steel tank. There the mass is stirred while being subjected to 165 degrees of steam heat. It then passes into a battery of rotary expellers, somewhat like huge kitchen meat grinders. Here the oil first begins to flow from the pressed copra. The oil is only partly extracted at this stage, however, and the meat is passed on to another jacketed tank to be subjected to 185 degrees of heat. Finally, it is placed in hydraulic presses, whose pressure of 5,000 pounds to the square inch brings out the remainder of the oil.

The oil is then forced by pressure through filters of heavy cloth and, after a treatment for elimination of fatty acids, is ready for commercial distribution. The fibrous portion remains as a cake and is used by millers in prepared foods for livestock.

Filipinos with their curious ox sled, transporting copra from the drying groves to a native village for shipment.

Copra is produced by breaking up the coconut kernel and drying the pieces in the sun. In this form the product is exported and later undergoes the processes which convert it into coconut oil and coco-stearin, the solid portion used in the manufacture of candles. The coconut oil is useful in the manufacture of marine soap that will form a lather with sea water. It is estimated that 1,000 full-sized nuts will yield upwards of 500 pounds of copra, from which about twenty-five gallons of oil are obtained.

A docked vessel at Portland, Ore., discharging its cargo of copra into the oil-extracting plant at the right. Above: Pneumatic tubes through which the copra is sucked from the hold.

New Hot Water Bag Saves the Skin from Burns

A HOT water bottle designed to protect the tender surface of the user's skin from burns, even when scalding water is used, has been invented by an Akron, O., manufacturer. This combination of intense heat and painless application is made possible, it is said, by the fact that the outer surface of the bag is studded with nearly 2,000 "thermo-nubs," little knobs of rubber like those on a rubber massage brush. These prevent the actual surface of the bottle from touching the skin, and they also permit air to circulate between the skin and the bottle. This air is heated by the bottle; and so dry, hot air is produced.

Hot air, because it brings about the rapid opening of the pores essential in reducing pain, has been regarded by many physicians as ideal in healing cases of rheumatism, sciatica, inflammation, and similar ailments. Moreover, the skin is less susceptible to burns by heated air than by heated water. It is, then, in its production of intense healing heat that the advantage claimed for this new type of bottle lies. And because there is no need to insert a towel between the bottle and the skin, the makers say, the maximum benefit may be derived by the user. The photograph shows the new bottle applied to the shoulder.

Locomotive, in Endurance Run, Sets Record

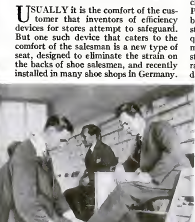
A LOCOMOTIVE recently broke an endurance record as remarkable, in its way, as any airplane mark thus far set. When Engine No. 4113, of the St. Louis-San Francisco Railway, rolled into Kansas City, Mo., from Birmingham, Alabama, the other day, it had covered 5,144 miles without having its fire drawn. It had eclipsed the old record of 3,500 miles, covered during a twenty-day period of continuous running between Kansas City and Birmingham.

Penny-in-Slot Doorbell Keeps Hawkers Away

AT LAST tramps, hawkers, and other nuisances may be discouraged from annoying the housewife. A Dutch inventor has devised an inexpensive device that will fit any doorbell and cause it to ring only when a penny is dropped into the slot. Visitors, errand boys, and others who have legitimate business at a house will not be out of pocket, however, for they may receive their coin back as soon as the door is opened to them.

High Seat for Customers Aids the Shoe Salesman

USUALLY it is the comfort of the customer that inventors of efficiency devices for stores attempt to safeguard. But one such device that caters to the comfort of the salesman is a new type of seat, designed to eliminate the strain on the backs of shoe salesmen, and recently installed in many shoe shops in Germany.



No need for the salesman to stoop over while fitting a shoe on the foot of a customer seated in this new high chair.

The customer sits on a high, comfortable chair to which is attached an extension board that serves as a foot rest for fittings. A ledge beneath the extension, a few inches from the floor, forms a convenient rest for the shoe box. The clerk may also place one foot upon it, for an "easy" position during fittings.

Bandaging with Silver

BANDAGES made of silver, instead of cotton, apparently have the power of healing surgical wounds, according to Dr. P. Maritsch, of Vienna University, Austria. The silver, applied in the form of a thin leaf, he reports, seems to have a marked antiseptic value.

Radio May Trace Mystery of Bird Migration

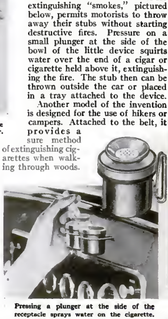
WHERE do the chimney swifts spend the winter after flying south and disappearing in the region of the Gulf of Mexico? How many stops does the scarlet tanager make on its long semi-annual flight from Canada to Peru and the nighthawk on its weary trek from the Yukon to the Argentine, and where are their favorite "rest stations"?

These and many other mysteries of bird migration which have puzzled scientists for years may at last be solved with the aid of radio. A beginning with this new method of investigation was made the other day by an ornithologist in charge of a bird-banding station in East Prussia, Germany. After attaching numbered bands to the legs of a number of storks, the investigator broadcast a request to European bird lovers for information regarding the birds. Soon reports started to come in from members of the radio audience. These showed that, five days after their release, the storks had been seen in the Carpathian mountains in Czecho-Slovakia. A couple of weeks later they were observed near Messini, in southwestern Greece, having flown about 1,250 miles in that period.

Dashboard Spray Puts Out Cigarette Butts

GOVERNMENT experts report that twenty percent of the $50,000,000 annual loss in forest fires in the United States is due to the carelessness of smokers, and that most roadside fires are caused by passing motorists who toss out burning cigarette or cigar stubs.

A new auto dashboard device for extinguishing "smokes," pictured below, permits motorists to throw away their stubs without starting destructive fires. Pressure on a small plunger at the side of the bowl of the little device squirts water over the end of a cigar or cigarette held above it, extinguishing the fire. The stub then can be thrown outside the car or placed in a tray attached to the device. Another model of the invention is designed for the use of hikers or campers. Attached to the belt, it provides a sure method of extinguishing cigarettes when walking through woods.



Pressing a plunger at the side of the receptacle sprays water on the cigarette.

Motor Buses Replace Last of Vermont Trolleys

With appropriate obsequies that included burning a crape-covered street car and playing Chopin's funeral march, Vermont recently abandoned the trolley car as a means of transportation. The last line in operation, between Burlington and Essex Junction, a distance of sixteen miles, is now closed, leaving the state without a single trolley track that is used. Motor buses have taken the place of the once popular electric cars.

Curiously enough, it was in Vermont that the world's first experiments in connection with the application of electric energy to transportation were made. These were conducted at Brandon in 1835, when Thomas Davenport made a number of models of railway motor cars operated by batteries. Other experiments along the same line were made, but it was not until after the electric dynamo had been perfected that practical results were achieved.

Numerous attempts to apply the motor and dynamo to traction purposes were made between 1870 and 1880. The first overhead system was built in Kansas City, Mo., in 1884, and the first electrical street car line to replace horse cars was started in Baltimore, Md., in 1885. A successful eleven-mile trolley system was installed at Richmond, Va., in 1888, and by 1890 nearly 150 American cities had electric lines in operation.

Service Set Clamps to the Card Table

Card tables are saved from being marred by stains from wet drinking glasses and burns from cigarettes by a bridge service set recently placed on the market.

The set consists of a drinking glass holder, an ash tray, and a clamp for holding the shuffled deck of cards made in the form of an arrow pointing to the next dealer. It is made of a resin composition trimmed with nickel, and may be clamped to each of the four corners of any table. The device not only protects the card table from stains and burns, but prevents drinking glasses from being knocked to the floor and gives the players more "elbow room."

The convenient new service set clamped to a card table. A pointer indicates the next dealer.

Huge "Elephant Ear" Leaf Is 47 Inches Long

"Elephant's" ears are not the exclusive property of elephants but are grown also, as leaves, on shrubs related to the calla lily. These huge leaves are a bright green and, when broken, give out a sticky, white milk. They are often more than a yard long; the one being measured below, grown in California, is forty-seven inches long and thirty-one inches wide. It is said to be the largest in America.

The plant which produces these giant leaves is called the taro. It is a subtropical plant, native to Hawaii and the Fiji Islands, but is sometimes found in California, Japan, and the West Indies. Its large, starchy roots are edible and nutritious. In Japan the tuber is eaten as Americans eat potatoes. In Hawaii the root is pounded to a paste and allowed to ferment, in which form it is eaten as the famous Hawaiian "poi."

Said to be the largest "ear" in America, this leaf of the taro plant is forty-seven by thirty-one inches.

Young Geologist Unearths Bones of Ancient Whale

In the collection of rare fossils at the Smithsonian Institution, at Washington, D. C., are the petrified skull and bones of a whale which scientists say are at least 3,000,000, and perhaps 8,000,000, years old, probably the most ancient remains of their kind found in America.

The skeleton was discovered at Prince Frederick, Md., not long ago, by America's youngest geologist, William L. Jones, of Baltimore, a seventeen-year-old member of a Johns Hopkins geological survey party. It took five days' digging to unearth the huge bones. The skull alone is seven feet long and it is estimated the entire monster measured thirty-six feet.

Round Playing Cards Are the Latest

Round playing cards have recently made their appearance in England. According to the designer of the new pasteboards, their shape facilitates shuffling and dealing. Six sets of spots and numerals are distributed around the edge of each card, so that the suits and numbers may be read easily regardless of the cards' position in the hand. On account of the greater width, which makes it almost impossible to hide the cards in the palm of the hand, and the absence of corners, it also should prove an effective weapon against cheating.

Circular playing cards, though a novelty to modern card players, are not exactly new; the Persians and Hindus used round cards in their games centuries ago. In Europe, however, where card playing was introduced in the Middle Ages, the counters were oblong and about the same size as those used today.

Puppet "Slaves" Found in Graves of Egyptians

"Slaves" to do their work in the hereafter were buried with the Egyptians of about 2000 B.C. A collection of these substitute workers, or "ushebtis," were recently placed on exhibition in the Egyptian Hall of the Field Museum of Natural History, in Chicago. They are small portrait statues of the departed, in mummy form, executed in painted wood, clay, glazed earthenware, terra cotta, and painted limestone. They had the additional function of serving as a home for the souls of their dead models.

The earliest conception of heaven among the Egyptians, who since the Stone Age engaged chiefly in agriculture, was a farmer's paradise, where grain grown by the souls of the dead would reach a height of twelve feet. Later, under the influence of priestcraft, this conception changed to one of a lazy man's paradise where all necessary toil was to be done by magic substitute laborers. The ushebtis were placed in small coffins of their own.

New Utah Highway Pierces Canyon Cliffs

Interior of the highway tunnel, nearing completion. It is a mile and one eighth long, with paved roadway.

The dotted line in the photograph at left indicates the course of the tunnel through the cliffs. At its highest point it is 4,000 feet above the canyon bed.

One of six galleries cut from the tunnel through the wall of Bryce Canyon to afford tourists an occasional view.

A REMARKABLE new section of the Pan-American Highway, which eventually will connect Alaska and South America, is being opened in Utah. Through the "bad lands" of the southwestern part of the state, the roadway stretches for nearly twenty-five miles, in one place burrowing for a mile and one eighth through the solid rock of a mountain chain. This tunnel is said to be the longest tube for the exclusive use of automobile traffic ever constructed outside of a city.

The new short-cut route clips more than sixty miles from the traveling distance between Zion National Park and Mt. Carmel for overland tourists. It is eighty-five miles long, compared with the old road distance of 149 miles.

At six places in the course of the tunnel, galleries lead out to the precipitous wall of Bryce Canyon, whose course the tunnel roughly follows. From these vantage points, travelers may view the white and vermilion cliffs at the other side of the canyon.

At its highest point, the tunnel passes through a mountain four thousand feet above the bed of the canyon. The underground highway is hard-surfaced throughout, so that tourists may speed from gallery to gallery with all the comfort of riding on a city boulevard.

Rattlers' Den Dynamited, but Snakes Survive

A RATTLESNAKES' lair that continues to be inhabited by scores of reptiles, despite the fact that it has been dynamited several times, was found some weeks ago near Wheeler Park, Nevada, by E. Raymond Hall, curator of mammals in the University of California Museum of Vertebrate Zoology. In proof of the existence of the den and in confirmation of hitherto unsubstantiated stories that rattlers live in colonies, the scientist returned to Berkeley, Calif., with twenty-five snakes he and an assistant had shot.

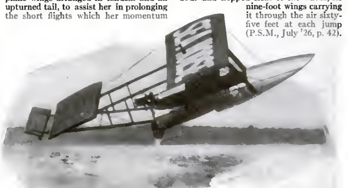
Before starting for the lair Hall was told by the county game warden that only a couple of days before 149 snakes had been killed there. This wholesale destruction apparently had made little impression on the reptiles, for when the hunters arrived at the den, Hall reported, they found fifty of them.

The lair, a sunken place at the end of a butte about 250 yards from the Pike's Peak Highway, was discovered five years ago by sheep ranchers. Since then, the hole has been blasted repeatedly with large charges of dynamite, and concerted rifle and shotgun attacks have been made on the snakes each spring and fall by residents of the near-by town of Ely, but to no avail. Scores of the creatures appear to survive in some subterranean home in the rocks of which the den is evidently the only accessible portion.

Outboard Motor Boat Soars above the Waves

THE novel spectacle of an outboard motor boat leaping from the water and soaring on wings through the air like a flying fish was witnessed at Auburndale, Fla., the other day. Speeding up the motor of his specially equipped *Sea Horse* at a terrific rate, Harrison Fraser, one of America's greatest outboard pilots and speed demons, accomplished that feat. The *Sea Horse* is equipped with small airplane wings arranged in tandem and an upturned tail, to assist her in prolonging the short flights which her momentum initiates. Thus she is enabled to skim over the waves in a series of long leaps. The speed craft is driven over the water by a two-cylinder, sixteen-horsepower outboard motor.

Fraser is not, however, the first to try equipping a motor boat with wings. A little over two years ago, the *Sea Flea*, in a trial off the coast of France, took off from the water at a speed of sixty miles an hour and hopped clear of the waves, its nine-foot wings carrying it through the air sixty-five feet at each jump (P.S.M., July '26, p. 42).



The winged outboard motor boat *Sea Horse*, driven by Harrison Fraser, soaring clear of the water during a trial at Auburndale, Florida.

Chemicals Injected into Tree Fireproof Lumber

BY INJECTING into living trees a new fire-resisting mineral "soup," experts at the College of Forestry at Tharandt, Germany, have produced lumber that is said to be strongly resistant to flames. The fireproofing process consists of feeding a thin solution of chemicals to the tree through holes bored in the trunks close to the ground. As the sap rises, the solution rises with it and gradually spreads to all parts of the tree, "mineralizing" and fireproofing it without interfering with its growth. The solution used is formed of compounds of silicon and fluorine and other chemicals.

It has been pointed out that forest fires such as destroyed many valuable tracts of timber in various parts of the country during last summer's drought may be materially lessened and ultimately, perhaps, prevented entirely by this scheme.

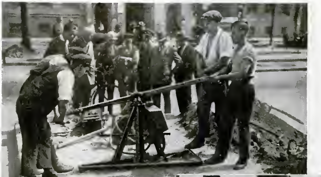
Successful experiments to produce colored woods, carried on in Maine for some time (P.S.M., Aug. '29, p. 69), employ a similar process. Dye solutions are injected into the trunks of the trees and rise with the sap, coloring the wood.

African Rivers May Hold Fortune in Ivory

THE great rivers of Africa must be mines abounding in a wealth of ancient ivory, if a new theory explaining the mysterious disappearance of dead elephants, advanced recently by Sir William Gowers, governor of the British colony of Uganda, proves correct.

Where do elephants go when they die? Naturalists and explorers for years have tried to find the answer. According to legend, the dying pachyderms drag themselves to some remote elephant cemetery. Such a place, however, has never been found, and neither have the majority of the 2,000 wild African elephants which, it is estimated, die each year. Sir William's theory is that the animals, when old, go to the nearest river to drink, and that most of them drown there.

Cable Laying Machine Bores under Street

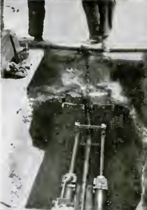


Workmen furnishing the pressure to operate the hydraulic ram, shown at the right.

UNSIGHTLY, torn-up streets, with their prolonged inconvenience to pedestrians and vehicular traffic, are eliminated by a new cable-laying machine recently tried out in Berlin, Germany. The device is designed to lay underground telephone and electric cables and gas and water pipes without tearing up the pavement. A hole at each side of the street is all that is necessary.

The apparatus consists of a hydraulic ram and a long piston. The ram, placed in one hole, forces the piston horizontally through the earth underneath the street. When the piston breaks through into the hole at the other side, toward which it is aimed, the cable is fastened to it. The machine is then put into reverse, pulling the cable through the hole made by the piston. The pressure for the ram is generated by four men operating handles like those of a railway hand car.

In tests, the device is said to have "laid" a cable in five hours, the traffic on the roadway above going on uninterrupted in the meantime.



The piston, pushed forward, makes a hole through which it pulls the cable on return trip.

Six-Wheel Army Truck Speeds Cross Country

A NEW six-wheeled army reconnaissance truck that needs no antiskid chains to assist it up steep inclines, over sand dunes, and through the roughest terrain was tested recently in the vicinity of London, England, by the British army. It proved its ability to cover exceptionally rugged territory in faster time than even the highly efficient trucks now in use. The double set of wheels at the rear afford extra tractive power. In addition, the rear wheels are mounted in such a way that they can adjust themselves automatically to inequalities in the surface of ground over which they roll. This latest model is expected to prove particularly useful for service in sandy regions, or over the soft ground of swampy districts.

The flexible mounting of this army truck's rear wheels gives it maximum traction over rough ground.

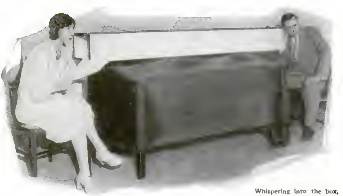
Intelligence No Guide to Manual Skill, Tests Show

A BOY who falters in reciting Lincoln's Gettysburg Address and is in the dark as to when to use "who" or "whom" may surpass his smarter brother in constructing a kite or fixing a toy engine.

That, in substance, is the conclusion of Dr. Frieda A. Kiefer, a psychologist of Watertown, Mass., who tested the manual dexterity of two groups of children, ranging in age from eight to twelve years, the other day. One group consisted of ninety-five boys and girls of superior intelligence; the other of ninety-seven children of normal mentality.

In none of the experiments did the brilliant youngsters exceed those of average intelligence in manual skill. The tests were designed to bring out various types of physical ability. Strength of grip was measured with a galvanometer. The rapidity with which a child could tap a telegraph key was determined with a Morse instrument. Steadiness of the hand was measured with electrical devices, and ability to control the hand was demonstrated with a stick which had to be moved a certain distance along a rod and stopped repeatedly at the same place.

Testing the Strength of a Stage Whisper



Whispering into the box, whose sound - absorbing walls duplicate conditions found in a filled theater.

HOW loud should a stage whisper be? A device recently displayed in the Museums of the Peaceful Arts, in New York City, attempts to give an answer by actual tests. A whisper that will carry to the back rows of an empty theater may be much too soft to be heard so far when the theater is full, for the audience acts as a sound-absorbing medium. The new instrument is designed to help directors in their difficult task of gaging just the right strength for the actors' whispers. It is a long and narrow box containing two corridors, one of bare wood to duplicate conditions in an empty theater, the other fitted with sound-absorbing material to represent a full "house."

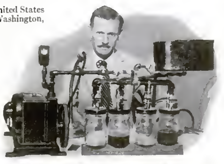
The actor speaks at one end of the box, the auditor sits at the other. A door at the end of each corridor permits first one and then the other to be used. Thus the difference between an unhampered whisper and a sound-proofed one may be tested on a small scale. The results gleaned from experiments with this instrument should furnish directors with a clue as to the results that they may expect under different conditions in the theater, and should greatly assist them in giving instructions to their actors.

Cathedral Windows Restored by "Shaving"

SHAVING chemical "whiskers" from cathedral windows by means of ordinary safety razors is the unusual method recently adopted to restore stained glass panes in England. Not long ago, Dr. Alexander Scott, of the British Museum, examined the windows of Wells Cathedral, in Somerset, and found that sulphuric acid fumes from gas lamps used for illumination, combined with dust from the stone with which the building is paved, had encrusted the glass. After a series of chemical and microscopic tests it was decided that the priceless windows could best be restored to their original beauty by shaving off the deposits.

Used Auto Engine Oil Reclaimed in Tests

INVESTIGATORS of the United States Bureau of Standards, at Washington, D. C., have a new method of reclaiming used oil drained from automobile crank cases. The apparatus consists of a still, a condenser, and a vacuum pump connected to a series of containers in which various grades of oil are separated. If the new method proves as successful on a large scale as the tests are said to have been, an important saving in lubricating oil, 415,000,000 gallons of which is used in the United States in one year, may be effected.



Dr. Winslow H. Herschel, of the U. S. Bureau of Standards, with the apparatus devised to reclaim old automobile lubricating oil.

Electroscope Finds Lost Tube of Radium

WHEN a small brass tube of radium, valued at $4,000, disappeared from a Los Angeles hospital recently, experts who were put on its trail borrowed an electroscope from the California Institute of Technology to help them find it. The electroscope consists of two hairlike quartz fibers wrapped with platinum in a container under a high pressure and charged with electricity from a dry cell. The emanations from radium discharge an electroscope and allow the fibers to come together.

The search began in the room where the radium was last seen. There the electroscope's fibers wavered slightly. The lost mineral's route was traced through the hospital and the grounds to the incinerator. But it had left the incinerator. Apparently it had gone to the city dump, so the tracers went there. At the dump the fibers of the electroscope drew together, and the radium was found.

The "radium detectives" with the electroscope that helped them trail the precious substance.

Tribe Has Language That Cannot Be Written

A PEOPLE whose language cannot be written live in the Fergansk region of Soviet Russia, a Russian scientist recently reported to the Soviet government. They are the Doungans, who to this day possess no written language, although the art of writing was originated thousands of years ago, surviving examples dating as far back as 4700 B.C.

The Doungans originally were a Chinese tribe which, about one hundred years ago, moved to Russia. Their language, based on Chinese dialects, absorbed Russian, Arabic, Turkish, and other words and idioms. The fact that they are Moslems, whose sacred book is the Arabic Koran, is responsible for the inclusion of Arabic usages.

Philologists have tried to transcribe the Doungan speech, but failed because some of the sounds are sung in tones of definite musical pitch, for which neither the Russian, Arabic, or other alphabets offer a form of expression. Picture writing of the Chinese fell short because it could not express the Russian and Arabic parts of the Doungan language.

Steamer Sights Swan in Transatlantic Flight

A "LONE eagle" of the swan family was seen some weeks ago in mid-Atlantic by the passengers and crew of the steamship *Homeric*. The big snow-white, orange-beaked bird made a striking picture against the sky as it flew about 100 feet above the sea toward Europe.

The swan, like the ship, was about 1,000 miles from the nearest land, but it appeared untired and did not seek refuge aboard the liner. Though swans are migratory birds and travel south in winter, they are rarely if ever seen over the ocean. A peculiarity of the birds is that, though they frequent fresh water in summer, they are often found at the seaside in warmer climates during the winter.

Indoor Hopscotch Game Played with Marbles

THE age-old childhood game of hopscotch can be played indoors with a new toy manufactured by a Lindstrom, Minn., company. The hopscotch toy consists of a base to which is hinged a "springboard" with five holes in a row to accommodate a marble that does the hopping. The object of the game is to jump the marble from one hole to another, using the springboard, the winner being the player who reaches the fifth hole first. The first four holes are blocked on the underside, while the fifth is open to allow the marble to drop into a corresponding hole in the baseboard and end the "round." Chained to the baseboard at its free end, the springboard has only a limited arc.

Indoor hopscotch. It takes practice to make the marble hop from hole to hole on the board.

Quake Relieves Drought

AN EARTHQUAKE which caused thousands of dollars damage at Attica, N. Y., recently supplied the town with a much-needed supply of drinking water. It opened some underground streams, which soon filled two reservoirs that had been virtually emptied during the protracted summer drought.

Old Auto Engine Runs Portable Hay Baler

A PORTABLE hay baler that will pick up the hay from the windrows and turn out the bales in the field with a minimum amount of labor has proved practical, according to its designer, Arba Brutus, of Pine Village, Ind. On the hay baler frame he has mounted an old Ford engine, with a governor and an oversize radiator. The engine operates the baler, and a loader attached to the rear picks up the hay.

Only three "hands" are required to work the machine, as pictured above. One man drives the tractor that pulls the entire outfit; one feeds the hay into the baler; and a boy ties the bales with wire. The speed of the outfit is limited only by the capacity of the baler.

New Evidence That Sunlight Is Electric

NEW proof that sunlight is an electrical phenomenon comes as a result of recently announced determinations of the speed of electromagnetic waves and of the speed of light, declares Dr. Harvey L. Curtis, physicist of the United States Bureau of Standards.

It has long been known that both electricity and light travel at about the same speed—roughly, 186,000 miles, or a distance more than seven times around the earth, in a second. Exact comparisons were lacking. Then, in 1907, Professor E. B. Rosa and Dr. N. E. Dorsey, of the Bureau of Standards, found that there was an apparent discrepancy between the speed of light and that of electricity of only three parts in 10,000—an agreement too close to suggest coincidence.

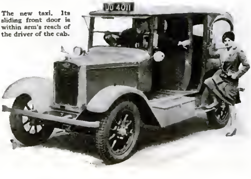
Six years later, F. E. Smith at the National Physical Laboratory in London pointed out a slight error in electrical units employed for these calculations. He obtained a revised figure for the speed of electromagnetic waves that two German physicists confirmed in 1921 within an accuracy of one part in 100,000.

Their figure for the speed of electricity was 186,282 miles a second. Recently Prof. A. A. Michelson, head of the University of Chicago's physics department, redetermined the speed of light as 186,285 miles a second. So close is this agreement with electricity that Dr. Curtis now declares it an "important confirmation" of the electric nature of light.

Novel Taxicab Has Sliding Door Entrance

A FLEET of two-seater taxicabs of a new and unusual design is soon, it is reported, to invade the streets of London, England. They are the invention of William Gowan, of Cape Town, South Africa.

The novel feature of the new cab is its substitution of a sliding panel for the usual door that opens outwards. This panel, placed in the front of the passenger compartment, may be operated by the driver without leaving his seat, or by the passenger. An oval window takes the place of the customary side door entrance, and a handgrip fastened to the side of the body lends assistance to passengers entering the cab.



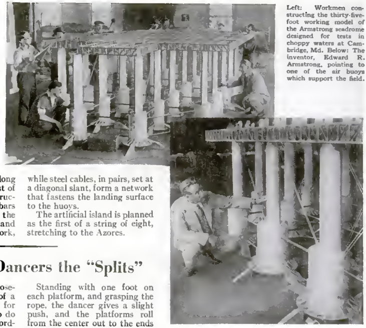
The new taxi. Its sliding front door is within arm's reach of the driver of the cab.

Build 35-Foot Model to Test Ocean Landing Field

FLOATING serenely on the high waves of the Atlantic between New York and Bermuda, an island of steel is expected soon to provide seagoing airplanes with an ocean landing field. Supported by a veritable forest of air buoys laid out in orderly rows, the world's first ocean airdrome, 1,200 feet long and 200 feet wide, will rise eighty feet above sea level.

A working model thirty-five feet long, constructed under the direction of Edward R. Armstrong, of Holly Oak, Del., designer of the seadrome (P. S. M., May '29, p. 20), will be given its trial test in choppy water at Cambridge, Md., shortly. Should the test prove successful, a full-sized seadrome will be built along the same lines. Not even the wildest of storms should be able to harm the structure, the inventor says. Sturdy steel bars run from buoy to buoy, connecting the rows both lengthwise and across, and insure absolute rigidity to the framework, while steel cables, in pairs, set at a diagonal slant, form a network that fastens the landing surface to the buoys.

The artificial island is planned as the first of a string of eight, stretching to the Azores.



Left: Workmen constructing the thirty-five-foot working model of the Armstrong seadrome designed for tests in choppy waters at Cambridge, Md. Below: The inventor, Edward R. Armstrong, pointing to one of the air buoys which support the field.

Machine Teaches Dancers the "Splits"

BOBBING up and down like a loose-jointed marionette at the end of a string, the user of a new machine for teaching prospective stage dancers to do "splits" soon acquires proficiency, according to its inventor, proprietor of a Los Angeles school of stage dancing.

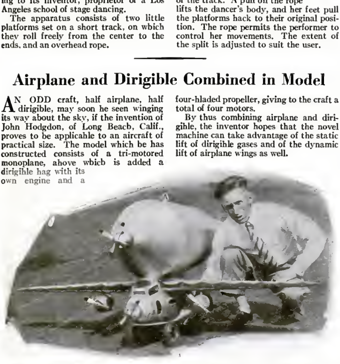
The apparatus consists of two little platforms set on a short track, on which they roll freely from the center to the ends, and an overhead rope.

Standing with one foot on each platform, and grasping the rope, the dancer gives a slight push, and the platforms roll from the center out to the ends of the track. A pull on the rope lifts the dancer's body, and her feet pull the platforms back to their original position. The rope permits the performer to control her movements. The extent of the split is adjusted to suit the user.

Airplane and Dirigible Combined in Model

AN ODD craft, half airplane, half dirigible, may soon be seen winging its way about the sky, if the invention of John Hodgdon, of Long Beach, Calif., proves to be applicable to an aircraft of practical size. The model which he has constructed consists of a tri-motored monoplane, above which is added a dirigible bag with its own engine and a four-bladed propeller, giving to the craft a total of four motors.

By thus combining airplane and dirigible, the inventor hopes that the novel machine can take advantage of the static lift of dirigible gases and of the dynamic lift of airplane wings as well.



John Hodgdon, Long Beach, Calif., inventor, with his model of a strange flying machine that combines a tri-motored monoplane with a dirigible. The envelope, above the wings, also has a propeller.

Signs of Life at Chicago 600 Million Years Ago

FOSSILIZED animals and plants found in rocks from the site of what is now Chicago give evidence of the existence of a low order of life in that region 600,000,000 years ago, according to Associate Curator Henry W. Nichols, of the Department of Geology at the Field Museum of Natural History, Chicago, Ill. The rocks of a still more ancient era are deeply buried in the vicinity of Chicago, and their records are obscure and difficult to interpret, he says.

"The geological history of Chicago," adds Curator Nichols, "has been peaceful and uneventful to a degree only occasionally encountered. There have been no volcanic eruptions, no formation and destruction of mountains, and, in short, no geological forces have here acted with that vigor, common elsewhere, which has left traces in broken, folded, and contorted rocks."

Though the site of the city has been many times submerged by the sea and has emerged again, such processes have been slow and orderly, so that the rocks under the city still lie nearly as horizontal as when they were deposited.

"The changes of level which have admitted and driven back the sea have not been great," Curator Nichols continues. "Only once has the region stood at any great elevation, and at no time have the submerging seas attained any great depths. Even at the present day a depression in the land levels of only 600 feet would again submerge Chicago."

Australia to Have Greatest Arch Bridge

VIEWED from the air, with the panorama of the city for a background, the new arch bridge at Sydney, Australia, is an impressive sight even in its unfinished condition. When completed it will be the world's greatest arch bridge, with a central span of 1,650 feet (P.S.M., Jan. '29, p. 56).

The aerial photograph shows the approach to the northern side of the bridge, looking toward Circular Quay at the head of Sydney Cove. The Cove, across the mouth of which the bridge is being constructed, is one of the many inner bays into which the intricate harborage around Sydney is divided. On the further side of the entrance the steel construction may be seen getting under way, and atop the pylons on both sides are the creeper cranes used in swinging the heavy steel beams in place.

The present largest arch bridge is the Hell Gate Bridge across the East River, New York, connecting the Borough of the Bronx with Long Island. It has a span of 978 feet.

Aerial view of the half-finished arch bridge at Sydney, Australia, to be the greatest of its type.

Mental Disorders Increase in Spring, Figures Show

APRIL and May are the "craziest" months in the year, according to Dr. R. Hopmann, of the University of Cologne, Germany. More people lose their mental balance during these two months than in any other equal period, his report says.

Statistics on the fluctuations of nervous diseases, which Dr. Hopmann collected, support his idea that in the spring the human mind is less stable than at other times. Police records, too, are said to show that the number of suicides and crimes of passion is highest during these two months. The reason for such mental disorders, Dr. Hopmann says, may lie in the lack of sufficient ultra-violet in the sun's rays during the long winter or in the effect of sudden changes in weather upon the system.

American Party First to Scale Alpine Peak

THE top of Mount Giultschi, a 14,700-foot peak in the Italian Alps, recently was reached for the first time by a party of American mountain climbers, headed by Albert Rand Herron. The same group is planning to scale Mount Elhurz, in the Caucasus, which, 18,570 feet high, is the loftiest peak in Europe.

Seal Hunters Make Record Catch of 40,000 Skins

NEARLY 40,000 girls and women will be able to enjoy the luxury of sealskin coats or wraps this winter as a result of the record catch of seals made in the Bering Sea last summer. The number of skins collected was 39,253, the greatest harvest in forty years. With the prevailing fashion frowning on ample garments, the skin of one seal is sufficient to make a coat for the American woman of average size.

Until 1911, promiscuous seal hunting was permitted in Pacific waters, with the result that the herd, which once numbered millions, dwindled to about 122,000. In that year the United States, Russia, Great Britain, and Japan made a treaty to protect the seal from extermination. According to the latest seal census of the United States Bureau of Fisheries, the herd at present numbers almost 1,000,000, despite the fact that 300,000 pelts have been obtained in the eighteen years of protection. Under the present conservation policy, a constant increase in the herd and annual fur yield is predicted.

Test Steel-Paved Streets

STEEL as a wear-resisting material for street pavement is to receive a test at Chicago, where an experimental strip ten feet wide and 120 feet long has just been laid. Wavy strips of steel form a wide mesh an inch and a quarter deep similar to a steel floor mat. The mesh is filled in with asphalt, which forms a thin upper covering.

One Radio Set Supplies 2,000 Headphones

THE entire population of Sing Sing Prison, at Ossining, N. Y., can listen to a radio program at one time, through a hookup designed and installed by one of the prison's inmates who was an electrical expert before entering the prison. The system connects more than 2,000 headphones and twenty-one loudspeakers with a central radio receiving outfit. The programs are tuned in on this set, and all inmates listen to the same broadcasting. Although the prison covers several square miles and comprises scores of buildings, the quality and volume of reproduction is remarkably good.

The central radio room with its elaborate equipment is shown in the accompanying illustration. At the extreme left may be seen a loop-operated receiver. At the right are the six three-tube audio amplifiers. The first supplies the twenty-one loudspeakers; the others supply the headphone groups numbering 300, 680, 150, 680, and 350, respectively. The amplifier units are in multiple series and are so wired that if one gets out of order the rest will continue to function.

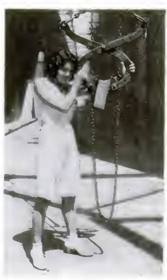
Apparatus that supplies prison inmates with radio programs. The designer of the hook-up is seated before the receiving set at the left. The six three-tube amplifiers are in the two boxes to the right.

Movie "Sets" Shifted by Overhead Railway

A section of a movie "set" carried on the overhead railway, operated from a switchboard.

An ELEVATED railway for shifting scenery is the latest device for saving time and labor employed by a large moving picture company in Hollywood, Calif. An electrically operated railway, more than two miles long, has been suspended in the air between the construction shops and the company's seven stages. The "cars" of this road consist of tongs that grapple the scenery and are suspended from wheels that run along the overhead track.

The miniature "elevated" consists of one main line between the shops and the "sets," with eight sidings, one to each stage and one to the shops. There are also three passing sidings, so that three cars may be operated simultaneously.



One of the railway "cars"—tongs suspended from wheels that run on the two-mile overhead track.

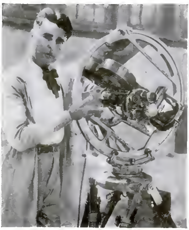
The cars are controlled from a tower switchboard operated by one man. Only two other men are required. One attaches hook or chain to pieces of scenery in the shops, the other guides these into place on the stages. These three, it is said, do two thirds more work than the eight men and large auto truck formerly employed.

Sections of scenery weighing up to 2,000 pounds can be handled, and the carriers are so well balanced that a girl can load or unload them with ease.

Revolving Camera Makes Planes Do the Loop

SAILING on an even keel, a ship, photographed with a new revolving camera recently tested in Hollywood, Calif., may seem to moving picture audiences to be rocking violently in the grip of a hurricane. By a few turns of a crank, an airplane may be made to perform in illusion its repertory of tail spins, loop-the-loops, and other thrilling stunts without actually once departing from a straightforward horizontal course. And, if such a fantastic effect is ever desired for a picture, a whole world may be turned topsy-turvy in a few moments.

The novel camera that is said to be capable of producing such surprising spectacles is mounted on a large wheel within another still larger, fixed on a tripod. Skillful manipulation of the crank that turns the first wheel gives the camera man control of the rotation or oscillation of the camera so as to obtain the effect desired.



Neil Hamilton, movie actor, with the new revolving camera that produces topsy-turvy stunts for the screen.

Plane Breaks Kite String and Spoils a Record

WHEN George Kent, a fifteen-year-old boy of Clifton, N. J., wound in a thousand feet of twine the other day, he pulled to earth a green kite which is said to have broken the world's record for an "endurance flight." It had remained aloft twenty-two hours and twenty-one minutes. The previous record had been a twelve-hour "flight" made by a Passaic, N. J., kite-flyer.

At 9:20 in the morning, Kent sent up his *Spirit of Clifton*. All day and during the night he jockeyed it, keeping it in the air in spite of light winds. At 7:41 the following morning, the breeze died out completely and the flight of the green record-holder came to an end.

A few days later two boys of Pensauken, N. J., Victor Harris and William Edelman, attempted to beat the record, but their efforts ended disastrously. Their kite had been flying well when a descending airplane cut the string and the kite blew away.

Suggests Insect Hunting by Ocean Voyagers

INSECT hunting may become a popular pastime aboard ship if the suggestion of Dr. T. D. A. Cockerell of the University of Colorado receives the attention of voyagers. On a trip around the world recently, the professor noticed that the bright lights of the ship at anchor attracted insects from the shore. Taking advantage of these insect visits he was able to make collections from ports at which he did not land. An interesting collection could be made by travelers with very little effort, he said, adding that ships probably play an important part in the spread of insects throughout the world.

New Theater Programs Can Be Read in the Dark

THEATER programs that can be read in the dark are used by a London, England, playhouse. They are printed on black paper. The ink used is white and it contains a radioactive element. Seen in the dark, the words glow like the hands of a radium watch.

Patrons can find out which members of the cast are playing different parts without waiting until the intermission. The novelty is expected to spread to other theaters if it proves popular with playgoers.

Bark of a Rare Cinnamon Tree Worth $4,000

ONE of the costliest coats in the world is worn by a tree. As much as $4,000 is paid for the white-spotted bark of a variety of cinnamon tree growing in French Indo-China. The tree reaches a height of thirty or thirty-five feet. When it is stripped, the bark is divided into three parts. That from the upper portion of the trunk is valued by natives as a medicine. The home of the tree is the province of Thanh Hoa.

Volcano's Steam Will Heat Hotel in Hawaii

STEAM heat from a volcano will warm guests in the new Kilauea Hotel, on the island of Hawaii, if present plans are carried out. According to Dr. T. A. Jaggar, director of the Hawaiian Volcano Observatory, volcanic steam escaping from four holes drilled in the heated rocks beneath the structure will be carried to a huge boiler to raise the temperature of water which will be piped throughout the hotel. The steam itself will not enter the pipes because it contains corrosive acids that eat the metal. The boiler is to be made of noncorrosive metal.

This is only one of many projects for utilizing the heat of volcanoes to warm buildings and develop power. In such widely-separated countries as Iceland, Japan, and New Zealand, volcanic steam is now used to heat houses and to run laundries, Dr. Jaggar reports. Electric power is generated from the steam in California and in Italy. On the island of Ischia, near Naples, gardeners use volcanic heat to warm the soil of their vegetable beds.

Calls East Indian Island an Earthly Paradise

A LAND where worry, care, and illness are virtually unknown and evil is reduced to a minimum was recently described by Dr. John C. Hill, Director of the Department of Religion, Archeology, and Anthropology of the University of Southern California upon his return from a trip to the East. That happy land is the island of Bali, in the Dutch East Indies, just east of Java in the Indian Ocean.

The natives, the traveler reported, are almost perfect physical specimens who live a life in which physicians, rent collectors, and policemen play a negligible part. He said they were not only an exceptionally healthy, but also a highly moral, people. The island is about 100 miles long and its population numbers 1,000,000.

During his sojourn on the island, Dr. Hill inspected the famous temple of Boro Boedoer, an enormous structure covering nine acres, which was buried 1,200 years ago, and of which five levels or stories are now uncovered.

Long-Burning Fires Hold Endurance Records

WHEN it comes to endurance records, long-lived fires deserve the championship. A fire in a refuse dump at Rikers Island, near New York City, for example, has resisted for fifteen years all attempts to extinguish it. Yet this is a mere baby compared to the famous Kentucky coal mine fire that burned for half a century and was put out only when a near-by river was diverted into the shaft of the mine.

The Kentucky inferno has a rival, now over forty-five years old, in the Hocking Valley Coal Mine region near New Straitsville, Ohio. Started in 1884, this fire (P. S. M., Aug. '28, p. 30) is estimated to have destroyed billions of dollars worth of bituminous coal.

Palatial Hangar Has Novel Folding Doors

EQUIPPED with the features of the most up-to-date railroad station, the palatial new terminal at the airport of Los Angeles, Calif., now nearing completion, will provide luxurious accommodation for arriving and departing planes with their passengers.

One of the novel features of the terminal is the double set of folding doors, extending almost the entire width of the building. Though fitted with huge windows, they are so constructed that they may be folded upwards readily to admit incoming planes. The entrance thus provided is sufficiently large to permit huge tri-motored transport planes to taxi in and out of the terminal while carrying their full load of passengers. The design of the building architecturally is California mission style. Its construction has cost the city of Los Angeles several million dollars, it is reported.

Auto Balloon-Chasing a New French Sport

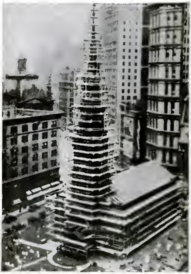
CHASING balloons in automobiles is the latest diversion of French society women. The first balloon-chasing contest was held recently at St. Cloud, and is reported to have attracted hundreds of entrants.

As fifteen small balloons took the air, the women, in automobiles, set out in pursuit of them, the idea of the sport being to follow by road the route taken by the aircraft and to telephone back to the starting point as soon as a balloon was found to have landed. Already, balloon-chasing clubs, with a membership chiefly of women, are said to be springing up in many parts of France.

Old Church Wears Odd Coat of Scaffolding

ENCASED in a shell of scaffolding, St. Paul's Chapel, New York City's oldest church building, located in the heart of its downtown section, presented a curious appearance during recent renovating operations. The building was erected in 1764. This year's repair work included patching the surface of the stone and restoring the steeple, which was added in 1794.

To facilitate the work, a cowl of scaffolding, with an iron framework laid out in rectangles, was constructed. Seen from a distance the church looked like an example of the latest in modernistic design, its steeple resembling an immense stack of witches' hats piled on each other with spaces between their brims.



Covered with scaffolding—St. Paul's Chapel in New York City, built 165 years ago, undergoing repairs.

Panama Canal Busy

THE great locks of the Panama Canal opened and closed for 6,413 vessels, representing twenty-three nations, during the year which ended last June. Of that total, the United States supplied more than forty-two percent, or 2,700 vessels.

What the New Radio Sets Offer

Answering the Questions Most Frequently Asked about the Qualities of the Year's Best Electric Receivers

By ALFRED P. LANE

Testing one of the latest radio receivers in the laboratory of the Popular Science Institute.

DECIDING what radio receiver to buy is harder this year than it ever was before. And, curiously enough, the difficulty now is due to the fact that there are so many really fine sets on the market.

Cabinet designs have become so standardized that dozens of different radio sets varying widely in power, price, and so on look practically alike except for minor details in the finish of the cabinet. Of course the more expensive sets have finer cabinets, but the less expensive outfits are housed in cabinets so carefully built that they give the impression of high quality. In many cases only an expert cabinetmaker can distinguish between them.

Some of the important questions Popular Science Monthly readers are asking about this year's radio receivers are answered below. The answers should prove helpful to prospective set buyers.

What are the meanings of all the new terms used to describe tone quality?

GOOD tone quality means just one thing—the ability of the radio receiver to reproduce, as perfectly as is scientifically possible, the tone produced in the broadcast studio. And that in turn means that the electrical and acoustical characteristics of the receiver are such that every tone frequency is treated in a uniform manner. None should be overemphasized, none suppressed, and none distorted. Many high-sounding but utterly meaningless phrases and words have been coined and applied to radio receivers to indicate that in one way or another they are better than other makes as far as tone quality is concerned. The basic fact remains, however, that a receiver is a piece of mechanical and electrical apparatus designed to do just one thing. That is to reproduce as faithfully as possible the air vibrations produced by the artists broadcasting. That function may be called by any name imaginable without improving the results.

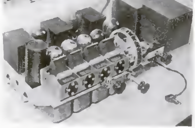
Why are screen grid tubes better?

THE screen grid tube, from a theoretical standpoint, is a remarkably efficient radio-frequency amplifier. If used in a well designed circuit it produces, in a practical fashion, more radio-frequency amplification than can be obtained by the older type tube. It must be remembered, however, that the presence or absence of the screen grid tube in the circuit has nothing whatever to do with the tone quality that a radio receiver will produce.

Just because a receiver has screen grid tubes does not guarantee improved tone quality. Thousands of radio receivers that have no screen grid tubes are being manufactured and sold this year, and they will give excellent satisfaction to their owners. If the prospective purchaser is interested only in local reception or he is located where a good antenna can be erected, screen grid tubes will be of no particular benefit. On the other hand, if he is located where it is impossible to put up a good antenna and local reception conditions are very unfavorable, then a set using screen grid tubes will help him to bring in stations that he otherwise might not receive. (P. S. M., Aug. '29, p. 71.)

Does power detection give greater distance and more volume?

THEORETICALLY, power detection gives better tone quality simply because it eliminates a certain amount of distortion which takes place with the older type of grid condenser and grid leak method of detection. The difference, however, is hardly noticeable except to the trained ear, and then only when the audio amplifier of the set and the loudspeaker are both of excellent quality. The fact that a set has or has not power detection should not be considered for or against it, provided the tone quality is satisfactory.



A close-up of the set being tested—a popular model this year, though it is not designed for the screen grid tubes.

A power detector is not as sensitive to weak signals as is the conventional grid condenser and grid leak method of detection. This, too, is relatively unimportant. In circuits designed to use power detection the radio-frequency amplification is greater than in circuits not designed to use the new system of detection. In some sets the power detector is coupled directly to a single audio amplifier stage using power tubes. This arrangement inherently produces less hum than does the circuit using two audio amplifier stages. In some cases, however, the manufacturer has taken advantage of the reduced hum to cut down the filter circuits so that the net result is little better than it has been in past years. In any case, modern radio sets are practically hum free in operation.

In what way are this year's sets better than last year's?

JUDGING from tests of a number of different receivers, the radio sets produced this year are more sensitive, more selective, and give better tone quality

Inspecting another of the new sets. This receiver uses one screen grid tube to aid in bringing in distant stations.

than last year's sets. The improvement is perhaps more noticeable in the low-priced sets than in the high-priced ones, simply because there was more room for improvement.

The increased sensitiveness and selectivity of this year's products is due in some cases to the use of the screen grid tube and in other cases to a better design of the radio-frequency circuits used with the type 227 tube. In addition, there has been a noticeable improvement in factory production methods, so that the individual tuned stages are more accurately synchronized with each other.

Do the new sets cost more to operate?

THE cost of operation of any radio receiver can be divided into depreciation, cost of current per hour, cost for tube replacements, and repairs.

Depreciation cannot be figured by any ordinary method because a modern radio receiver will last for years. The cost for electric current depends entirely on the number and size of tubes used in the set. If, for instance, a set uses three screen grid tubes, type 224; two heater tubes, type 227; and two power tubes, type 171A, it will use just as much current whether the set costs $100 or $300. In any case the amount of current consumed, as compared with sets of last year of approximately equivalent price, will be only a small fraction greater. If the set uses 245 power tubes the current drain will be somewhat heavier.

What is automatic tuning?

SOME of the receivers on the market this year are so built that the various local stations can be tuned in merely by pressing the proper button. The only advantage, of course, is in the time saved as compared with turning a dial to the proper number. It does not improve the actual operation of the set.

Remote control is being featured in at least one case. With this form of control the receiver can be tuned from any point in the room or in any part of the house if the house is wired for the purpose. This, too, is merely a convenience that has nothing to do with the set's reception.

What is the advantage of automatic volume control?

AUTOMATIC volume control is another improvement for convenience rather than operation. In one form, automatic control is obtained by the use of a special tube in the circuit, so connected that the strength of the received signal changes the plate current flow, and the change in plate current flow, in turn, changes the grid bias on the radio-frequency stages. The result is that all local stations sound about alike in volume. In addition, a hand control is provided to cut the volume below the level to which it is controlled by the automatic arrangement.

What is meant by uniform sensitivity?

A THEORETICALLY perfect radio receiver should be equally sensitive on all wave lengths or frequencies. Most radio receivers in the past have shown greater sensitiveness to signals on the lower end of the wave-length band; in other words, on the higher frequencies. A station received on 545 meters or 550 kilocycles, for example, usually gave considerably less volume from the loudspeaker than a station received on 236 meters or 1,170 kilocycles.

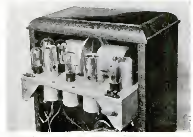
There are two reasons why this situation existed. First, the radio-frequency transformers then used were more efficient on the higher frequencies; and second, the natural tendency of the tubes to regenerate was greater on the higher frequencies.

To Aid in Choosing a New Radio Set

AFTER subjecting many of the nationally sold radio sets to careful tests in its laboratory at New York University, Popular Science Institute has prepared a list of those found to be highly efficient and of good value according to 1930 standards. This list may be obtained free on request.

Readers who wish help in choosing a set or who desire advice as to receivers suited to their needs should give full details. Test measurements on file will provide a basis for real help, providing readers will state what features are most important to them, and the price they are prepared to pay.

Requests for the list of approved radio equipment, or for personal help in buying, should be addressed to the Popular Science Institute, 381 Fourth Avenue, New York.



Housed in a novel cabinet with metal frame and wood panel, this set uses one screen grid tube and several 227 tubes. It also includes push-pull audio amplification.

These conditions still obtain to some extent, but other factors working in the opposite direction have been introduced into the circuit in some cases. The net result is a reasonably uniform degree of sensitivity on all wave lengths within the band used for broadcasting.

What is the advantage of push-pull amplification?

PUSH-PULL amplification is featured in a large number of the latest sets. The push-pull circuit definitely reduces distortion and therefore improves tone quality. Briefly, the characteristics of a power tube are such that a small amount of distortion is produced in its operation. In the push-pull circuit the distortion produced in one tube is balanced out by the distortion produced in the other tube. (P. S. M., Nov. '29, p. 71.)

Are the new speakers any better than those of last year?

THE high-grade loudspeakers this year produce no better tone quality than the high-grade speakers of last year, but in the less expensive models there has been a vast improvement. There is less difference in tone quality between a low-priced speaker and a high-priced speaker now than there ever has been in the past.

Do the new sets need antennas?

SINCE the latest sets are, on the average, more sensitive than their predecessors, in any given installation a shorter antenna will produce the same results as the longer antenna of previous years. In an unfavorable location where reception is poor at best and the building is of steel with wire lath construction, an antenna still is necessary for really satisfactory results. Of course, conditions vary so that it is impossible to give definite rules.

What new improvements may be expected next year?

IT IS difficult to see how any radical improvements can be made in the latest radio receivers. From the standpoint of tone quality, for example, it is extremely doubtful whether anyone except a trained musician could detect the difference between the type of reproduction obtainable from the best of modern sets and an outfit that was theoretically perfect. In other words, with the best sets of this year it is practically impossible to determine, when listening from another room, whether the music is from a radio set or from actual musical instruments.

Future radio receivers may be made even more sensitive and selective than they are at present, but any great improvement in sensitiveness would be of no use because the static level is, in any case, the limiting factor. Any great increase in selectivity can be accomplished only by sacrificing tone quality. Improvements from now on are likely to be in the nature of mechanical refinements in construction and operation, and of changes in cabinet design.

Useful Hints for the Set Builder

A Handy Radio Trouble Lamp

How to Silence the Squeals in Screen Grid and Audio Amplifier Circuits—Finding the Limit of Selectivity

A PIECE of apparatus that is indispensable to the dentist may be employed by the amateur radio fan to rig up a handy trouble-shooting lamp. The illustration on this page shows how the device is made by soldering the handle of a small dental mirror to a pencil-type nickel plated pocket flashlight. When the mirror is held in the proper position, and the flashlight button pressed, it is possible to inspect any part of a radio receiver which otherwise could not be examined. The light from the flashlight bulb is reflected by the mirror onto the work, and at the same time the mirror reflects the image of the part being inspected. The proper angle for the mirror can best be determined by experimentation.

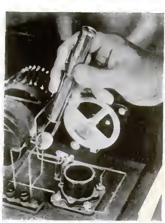
Probably the greatest use for this device will be found in inspecting soldered joints. Frequently when a soldered joint appears satisfactory when viewed from the top, an inspection of the bottom with this mirror device will show that the joint is far from perfect and may, in fact, be held together merely by a small piece of rosin that had been used as a flux.

This tool will be found helpful also in detecting broken wires and short circuits between two wires or between the terminals of a socket and a metal base.

Screen Grid Suppressors

IN THEORY, at least, the screen grid tube is so constructed that there is no internal capacity between the elements of the tube to cause feedback and consequent oscillation or squealing. In practice, however, the screen grid tube is not absolutely perfect; and, furthermore, it is extremely difficult to shield a radio set to meet the theoretical requirements. In consequence, screen grid circuits that contain two or more tubes sometimes go into violent oscillation when the knob that controls the volume is turned all the way on.

If a screen grid tube is not quite up to standard, or the shielding is not well arranged, or if there is a coupling somewhere else in the circuit, the tendency toward oscillation may be so great that it is impossible to attain satisfactory volume. The remedy in such cases is to add grid suppressors. The grid suppressor is a resistance connected in the lead to the control grids of the tube, which in the case of the screen grid tube is the lead to the cap at the top of the tube. Experiments will determine the best value, but in any case the resistance is far higher than that of a grid suppressor suitable for use in a radio-frequency circuit employing a 227 or a 201A tube. Ten thousand ohms or even higher may prove suitable. The insertion of this apparently extremely high resistance reduces the efficiency of the screen grid tube's operation very little. This is because the normal capacity in the grid circuit of the tube is extremely low. A considerable amount of resistance must be used to have any appreciable effect.



Inspecting solder joints with the trouble lamp, made with a flashlight and a dentist's mirror.

A B C's of Radio

THE only practical way to convert direct current into alternating current in quantities sufficient to operate one of the new electric type radio receivers is to use a rotary converter or motor generator unit. The motor generator consists of a direct current motor coupled directly to an alternating current generator. A rotary converter is essentially the same apparatus built as a single unit.

If 110 volts direct current is available, it is possible to purchase any one of several types of radio receivers especially designed to operate on that current; but for thirty-two volts direct current, a suitable motor generator or rotary converter must be used, or else the radio set must be run on dry cells for the B supply.

Stopping Audio Howls

AUDIO amplifier circuits play queer tricks at times. An audio amplifier, for instance, may operate for months without trouble and then suddenly produce oscillations ranging from a thumping "putt-putt" to a high-pitched squeal.

Various conditions may cause this behavior. The line voltage may increase slightly, the characteristics of the tubes may change somewhat, and so on. Trouble of this kind is most likely to develop in push-pull type audio amplifiers, especially if high ratio transformers are used in the circuit.

The safest and most certain remedy is to bridge the secondary winding with a high resistance. The value of this resistance may be from a half megohm to 50,000 ohms, depending on the characteristics of the circuit. The resistance should be connected from the grid terminal of the power tube socket to minus B or to ground. In the case of push-pull circuits two resistances are necessary, one for each of the tubes.

The mere fact that an audio amplifier does not produce an audible whistle or squeal when no signal is being received does not necessarily prove that there are no oscillations present. The oscillation may be taking place at a frequency above the range of audibility. Though a whistle of this kind may not interfere with reception, it should be eliminated because the oscillation results in excessive plate current and the tube overloads more easily.

Limits of Selectivity

THE theoretical limit of selectivity would be reached by a radio set that would receive on a single wave length or frequency; but if such a set could be constructed it would be useless for broadcast reception. It would tune so sharply that music or speech would be unintelligible. For broadcast reception it is necessary to have a receiver that tunes over a certain band of frequencies, and when ten kilocycles is mentioned as the ideal, this means that a receiver should tune an entire band ten kilocycles wide and reject all frequencies outside of the band.

The construction of such a receiver is practically impossible. Some sets approach it, but all sets bring in some signals on both sides of the desired band. If the local station to be eliminated is, say, 100 times or so more powerful than a distant station on the adjacent wave length, it is utterly impossible to eliminate the local so thoroughly that it cannot be heard.

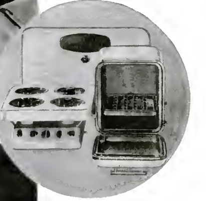
The New Household Inventions

No danger of pushing the cap into the bottle or spattering milk with a simple new milk bottle cap remover consisting of a prong that digs into the paper cap, lifting it off, when horizontal shaft to which it is attached is moved sideways.

Above: Cone-shaped heating coils in the new electric range (in circle at right) can easily be removed for cleaning.

This milk can opener also serves as a stopper and handle. Sharp points on a lever hinged to the handle punch two holes in the can. Pressing the lever's end lifts the points out of the holes for pouring; when released, a spring forces the points back into the holes.

Especially appropriate for bridge luncheons is a set of new salad or dessert molds. Made in the shape of diamonds, clubs, hearts, and spades, the novel forms offer new possibilities to the housewife who likes to be original in food preparation.



Devoid of obstructing legs, a new four-burner electric range, with a generous-sized oven, shown opened, is attached at a convenient height to the kitchen wall.

When the eggs are cooked to the proper degree of hardness, a new timer automatically lifts them out of the water. Four eggs can be boiled at one time with the device, which can be set to operate after any interval from one to five minutes.

A new washtub stand that rolls on casters eliminates the back-breaking task of lifting and carrying heavy tubs filled with water. The tub can be wheeled beneath a faucet and filled; afterwards it can be emptied by tilting over a floor drain. Once fastened to the stand, the tub need never be removed.

This new door wedge will hold a door open without slipping, due to the fact that it is made of rubber. Since the material is soft and elastic, it will not mar highly polished doors or floors.

A Well-Built House Is Cheapest

An Architect Tells How to Save Money by Spending It at the Outset for the Best Materials and Workmanship

BOB KERSEY saw Ed Townsend sitting off in a corner of the club lounge one afternoon, exuding gloom and evidently in need of cheering up. Bob dropped into a near-by chair and offered his friend a cigarette. "What's on your mind, Old Timer?" he asked.

"It's that house of mine. I'm just wondering if I wouldn't be better off to sell it."

Bob showed his amazement. "Sell it? When you and Mabel were saying only last week that you were so happy in it you hoped you'd never have to leave?"

"Yes, I know; but it's costing a blamed sight more to live in than I can afford, and it's keeping me broke. If it isn't falling apart in one place it's coming to pieces in another. It isn't so ancient, either; we've been living in it for three years, and it was only seven years old when we bought it. I spent a couple of thousand on repairs and redecorating when we moved in and thought I was through; but whenever I get a little ahead something has to be done to it that cleans me out.

"First the gutters and leaders had to be replaced. Then the hot water pipes clogged and I had to put new pipes in the heater. The cellar leaked and had to be lined with damp-proofing. We burn an unholy lot of coal, and even then are not really warm. There are places where the plaster cracks, no matter what I do. Some of the floors were so squeaky that I had to have them relaid. The roof springs a new leak every time it rains, and this morning there was a wet spot on the dining room ceiling that the plumber says comes from a leak in a pipe. It's rusted through, and he tells me that the only thing to do is to rip out all of the pipes and replace them.

"I NEVER would have bought that house if I had known it was so rottenly built. I can't afford to keep on living there; but I hate to wish it on anyone else. I'm up against it."

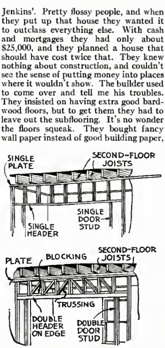
Here was a possibility that Bob had not considered. About to build a house himself, he gave thought for the first time to the possibility of repair and maintenance expenses that he might not be able to meet. He lost no time in talking that over with his architect.

"Say," he exclaimed. "What's this house going to let me in for, anyway? I've got money enough to build it, but how can I tell whether I'll be able to keep it going?"

The architect laughed. "Calm down, Bob," he said, "you're not going to get into any such trouble as that. I know all about Townsend's house, and it's been a surprise to me that he's lived there as long as he has. It was built by the Jenkins'. Pretty flossy people, and when they put up that house they wanted it to outclass everything else. With cash and mortgages they had only about $25,000, and they planned a house that should have cost twice that. They knew nothing about construction, and couldn't see the sense of putting money into places where it wouldn't show. The builder used to come over and tell me his troubles. They insisted on having extra good hardwood floors, but to get them they had to leave out the subflooring. It's no wonder the floors squeak. They bought fancy wall paper instead of good building paper, and when the wind blows the house leaks like a sieve. Nobody could see the water pipes, they said, so why spend much money on them? Anything that would carry water would be good enough.

THE illuminating experiences of the Kerseys in planning the materials for their new home are concluded in this article, in which they learn the economy of first-class construction. In another helpful article next month, Mr. Whitman will tell how to get the most out of electricity in wiring the home for lighting fixtures and labor-saving appliances.

By ROGER B. WHITMAN



Above: A typical example of flimsy framing around a large opening, resulting in sagging and cracked plaster. Below: How extra labor and materials give lasting strength and rigidity.

"ED IS having trouble with the roof because the Jenkins' wouldn't let the builder use rustproof nails. They guessed that bare wire nails would be all right, and now they're rusting away and the shingles are coming off. The Jenkins' ran into the same trouble that Ed has. The house costs more to keep in repair than they could afford, so they sold for what they could get, and Ed thought he had a good buy."

The architect tapped Bob on the knee. "Listen to this, Bob," he said; "the cheap house isn't the one that costs little to buy, but the one that costs little to live in. You pay the purchase price only once, but the cost of occupancy goes on as long as the house does.

"For an example, take your own house. Well built in the usual way, with the walls sheathed, lined with building paper and finished with clapboards or shingles, and with an ordinary roof, you'd burn at least twenty tons of coal a winter to be comfortable. With insulated walls and roof, metal weather strips and storm sash, you could heat it with fifteen tons at the outside. Insulation would add maybe $350 to the cost of the house, and weather-stripping and storm sash $250 or so more. For that extra $600 you'd pay $30 a year interest; but you'd save $75 on the coal bill. There'd be less stoking and ash handling, of course; and with a more even distribution of heat and fewer drafts the house would be more comfortable.

"There you have a good example of how you can save money by spending it. If you leave out the heat-proofing you make one saving of $600, while if you put it in you save a clear $45 every year that the house is occupied.

"YOU could save money by using a wood shingle roof; but there'd be a repainting charge every few years, and you'd have to put something aside each year against the time when it would need replacing. Roughly, that roof would cost at least $30 a year. A roof of rough asbestos shingles that look like hand split wood, or of good quality slate, will cost maybe $400 more to build, but unless an airplane lands on it or you have some other accident, you'll never spend a nickel for repair or maintenance. The annual charges for interest on the higher price of the permanent roof will be $20, so you'll more than break even. The house will have higher value, too.

"If the Jenkins' had asked questions they'd have learned that the water around here raises the dickens with

Courtesy Home Guild of America

Architect's designs for an attractive living room (above) and library. The comfort to be derived from such rooms depends not so much on their surface appearance, however, as on durable materials and workmanship, which prove cheapest in the long run.

galvanized steel. Brass pipe all over would have cost an extra $100 or so, and would have saved Ed Townsend the $600 he'll have to pay for replacement. The galvanized gutters and leaders that were put in lasted only seven years, and Ed told me the cost of replacement with some more galvanized was $275. The first cost was $200, so with what Ed spent those gutters and leaders set somebody back $475, plus whatever had been spent for painting. Copper gutters and leaders would have been about $400 higher, but they would still be as good as when they were new. There's another place where money would have been saved by spending it."

"THIS is a slant on building that I've never had before," said Bob. "I hadn't realized that what a house costs to live in depends on how it's built. If I build a wood house I'll have to paint it every few years, while if it's stone I won't."

"Exactly. Brass-plated hardware looks fine when new, but in a few months it gets shabby, and it'll cost more to replace than solid brass would have in the first place. The drip from it will stain the woodwork, too, and there'll be the cost of repainting. Substantial things cost more than cheap imitations, but they last longer.

"When you look at a house as an investment as well as a place to live in, you get a broader view of it. You don't buy a railroad bond because you like the color of the ink, but because you think that the company issuing it is so solid that the bond will always be worth what you paid for it. Ask yourself the same question about a house, and if you don't get the same answer, don't buy it. As far as value goes, Jenkins might just as well have put his money in a wildcat oil well as in that house, and that goes for Townsend, too.

"THE place where Ed said the plaster was always cracking is the wall over the ten-foot opening between the living room and the dining room. I watched it being built. A wall like that, with no support underneath, should have diagonal braces to form a truss; but to save money that wasn't done, and the weight comes on a couple of two by fours that form the top of the opening. There's no stiffness to them, and the plaster cracks as they sag and spring. It wouldn't be so bad with metal lath, because that has enough strength to more or less hold things together; but with wood lath it's hopeless."

"But where was the Jenkins's architect all that time?" queried Bob. "Why didn't he tell them those things, and show them where they were wrong?"

"They didn't have one. They thought that all an architect does is to draw plans, and they got theirs ready-made from a book. They wanted a few changes, but said that the builder could make them, and their only specifications were for inside and outside finish. They let him do as he liked about everything else. He needed work about then, so he went to it; but with not enough money to do a good job he could give them the show things only by cheapening the other parts."

"Exactly what do you mean by 'cheapening' a house?" Bob asked. "Using poor material?"

"That, and not using enough material, and poor workmanship. That arch where the plaster cracked is an example. A wall must carry the weight of the parts above, and when you cut a hole in it for a window or a door, you have to put bracing around it to make up for what isn't there. You do the same with the hole in the floor where the stairs go through. A good builder will put a lot of material around those places, and a poor one won't. The longer floor beams are, the bigger they should be so that they won't sag, and that's another place where a poor builder will weaken things. He'll save money for himself by using timbers that are too light. They won't be stiff enough to carry the weight on them, and the floor will sway and creak."

The long floor beams for this spacious living room must be big enough to prevent sagging. If the beams are too light the floor will sway and creak.

"Did you see the story in the paper the other day about a family that moved into a new house, and the piano broke through the floor into the cellar?" asked Bob.

"No; but a few years ago I examined a house where that had happened. The beams were too small and were not braced, and two of them had big knots that took away half of their strength. Do you begin to see, Bob, that as your architect I'm doing more for your house than to lay out the plans? I'm specifying the sizes of the timbers and the way they are to be put together, and telling the builder just what materials are to be used and how he is to use them. When we ask for competitive bids every builder who tries for the job will know exactly what is wanted, and be able to figure closer than if he could make a choice between materials or had any leeway in the workmanship. That's part of an architect's job, and it's in just that service that the client should make a profit on the fee."

"IT SEEMS to me that there's more to it than that," commented Bob. "Your fee will be paying me a profit as long as I live in the house, because you will have made it cheap to live in."

"Right; and that brings up some suggestions. I'd like to see you put in a fireproof first floor over the cellar—steel beams and concrete. With all the litter that collects in a cellar, and a fire going in the heater and a flame in the hot water outfit, that's where fires are likely to start; but with a fireproof ceiling it can't spread to the rest of the house. I figure that you'll be able to do it for about $300 more than ordinary construction. I want you to have a dry cellar, too. Draintile should be laid along the footings, and the outside of the walls swabbed with tar or liquid asphalt. All of the floors will be double, of course, with the subfloor laid diagonally and covered with building felt.

(Continued on page 154)

Where the New Motor Cars Excel

By

MARTIN BUNN

From the pages of a catalogue the new cars came to life as Gus, the veteran auto mechanic, explained their fine points and showed where they embody improvements in materials and design.

"GOT time to reline my brakes this morning, Gus?" Kellogg called as he drove up to the Model Garage. "The linings are nearly worn through."

"Sure thing!" Gus Wilson replied as he swung the doors open. "Run her inside over near the bench."

Kellogg was rated as a good customer at the Model Garage. He handled his car carefully and intelligently, appreciated painstaking repair work, and, as Joe Clark, Gus's partner, once remarked: "He pays his bills instead of filing them in the waste basket!"

"Do a good job, now, Gus," Kellogg instructed while the veteran auto mechanic laid out his tools and placed the jacks. "I like to be able to stop quick and, believe me, when the brakes are right on this bus she'll pretty near throw you through the windshield. I'd like to see any four-wheel-brake car stop any quicker."

Gus smiled. "Guess you don't think much of four-wheel brakes," he observed.

"I should say not!" Kellogg snapped. "They're just a talking point to help 'em sell the junk they call automobiles these days. If you want to see a *real* automobile, take a look at this boat. No fool fancy business. Just plain good automobile."

"You've had five years of fine service out of it," Gus admitted. "Taking care of it the way you do, you ought to get thousands of miles more before it's really worn out. By the way," he suggested, "would you like to look over the catalogues of some of the new cars while you're waiting? Joe has a few on his desk. Hey! Joe!" he called to his partner, "bring out that batch of catalogues I saw you looking at this morning."

Joe popped out of his tiny office with a handful of gayly colored literature. "Thinking of buying a new boat, Mr. Kellogg?" he grinned.

"NIX!" Kellogg snorted disdainfully. "I don't think any of the cars they make now are as good as the one I've got. I'm satisfied with it."

"I don't wonder," said Gus as he measured a piece of brake lining and cut it to the proper length, "that you think four-wheel brakes don't amount to much. Lots of cars are running on the road with four brakes in such rotten shape they won't stop the car as quick as two brakes that work right. But if you ever happen to get behind some bird who has good brakes and he gets into a tight place so he has to jam 'em on, you're going to slam into him sure as fate."

"Maybe so," Kellogg admitted. "But how about these four-speed transmissions? Seems like a lot of hunk to me. What's the good of four speeds if you drive in high nearly all the time anyway?"

"It isn't the four speeds that count so much as the fact that you get what amounts to two high speeds," Gus explained. "Lots of times when you're boiling along a fine road at a good clip you kind of wish the motor wasn't turning over so fast it sounded like a bumblebee. Then when you get stuck in a lot of traffic or you have to push over steep hills and through lots of mud, you wish that high wasn't quite so high and second wasn't quite so low and noisy. The right kind of four-speed transmission takes care of both cases. In high, at high speed, the motor is as quiet as a mouse. In third you can crawl through traffic or plough up muddy, steep hills as easy as rolling off a log—and do it without any gear noises either. On long trips the higher gearing saves gas, too."

"If a four-speed transmission will do that," said Kellogg, "I'm all for it. What about this front-wheel-drive idea?"

"SOUNDS like hot stuff in some ways," Gus observed. "Of course it's so new that you can't tell how it will work out for a while yet. There's no doubt driving through the front wheels makes it possible to get the body down close to the ground. The car ought to ride easier. Taking weight off the rear axle should help. I can remember years ago how smooth-riding the old chain drive cars were. They had a light rear axle, too. But as far as that goes, there's nothing to stop 'em from getting the same light rear axle with the ordinary rear drive by fastening the differential gear case onto the frame and driving the wheels through universal jointed shafts as they do with the new front drives.

"Skidding should be less with the front drive and it is great for climbing out of ruts. Then there's no long propeller shaft to cause vibration if it doesn't happen to be balanced right."

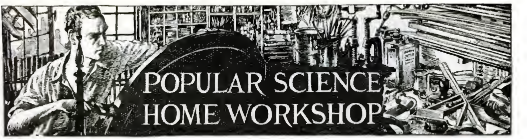
"You don't seem to be over-enthusiastic about the front drive," said Kellogg.

"I said it looks good in a lot of ways," Gus replied. "But what looks good doesn't always work out in practice. Nobody can say for sure until a couple of thousand cars have seen a few years on the road in the hands of all sorts of drivers. Of course the idea isn't really new. Twenty-five years or more ago there used to be some electric hansom cabs running around the city streets that drove with the front wheels and steered with the back ones. Seems to me the ideal way to *(Continued on page 138)*

Gus Says—

AFTER you get to know every bump and turn in a road you know when it's safe to step on the throttle and when you ought to take it easy. But don't get the idea that no car is ever going to come out of a side road just because one never happened to come out while you were passing. When you go whizzing by a blind crossing you're just asking the undertaker to have a good look at you.

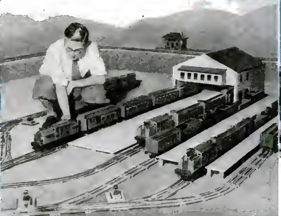
A man is likely to get mighty careless right around his own home town—he gets to know it so well he forgets about the chances for accidents. Lots of mighty sad accidents have been caused by backing out of the home garage. Make sure there are no children playing around before you throw in reverse and let in the clutch.



Operating a Model Railway System

By

FREDERICK D. RYDER, JR.



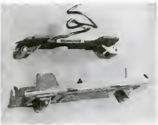
Making up the first section of the "Ace Limited" prior to sending it out through the yards for its "clear board" run.

A MODEL railway is, after all, merely a miniature edition of one of our real railroads. And, subject to the limitations of time and space, the model railway owner is faced with all the problems confronting the management of a real railroad.

The most important of these problems, once the model railway is constructed, deal with maintaining the power supply, the locomotives, the rolling stock, and the track in first-class condition.

Unfortunately, many have the idea that model railways are similar to other mechanical toys sold to children. Nothing could be farther from the truth. In proportion to their size, the better makes of model railways are, in every detail, as well built as their large prototypes.

Power obtained from dry cell batteries is satisfactory for operation in every respect save one—it is very costly. Consequently batteries should be crossed off the list as a power source if the house is wired for electric lights.



Two types of current collectors that are used on most model electric railway locomotives.

When direct current is available, it is possible to obtain the low voltage current required by the model railway by the use of a voltage reducer consisting of special resistance elements. The vast majority of homes, are, however, supplied with 110-volt, 60-cycle alternating current. This is ideal, for it permits the use of a step-down transformer wound to supply exactly the required voltages. There is no wasted power, a necessary evil with the direct current reducer.

Moreover, a model railway power station equipped with a transformer conforms more closely than most people realize to actual practice on a real railroad. If the transformer heats excessively, it is an indication that you are drawing too much current from it. The remedy is to divide the load and use two transformers, each one handling part of the load (see the diagram, page 78).

Do not attempt to operate two transformers in parallel, as you are almost certain to get in trouble.

The locomotive on the model railway, as on the real railway, is at once the most important and the most interesting unit in the entire equipment. On most real electrified railways, the current flows through an overhead wire and is collected from this wire by means of pantographs on the top of the locomotive. On model railways the best practice is to use an insulated rail placed between the rails on which the wheels run.

A current collector is fitted to the bottom of the motor frame in such a way that the small steel or brass rollers are held by springs in good electrical contact with the third, or insulated, rail. The electric current flows between the third rail and the running rails by way of the current collector rollers, the motor, and the driving wheels of the locomotive.

The motor consists of a stationary horseshoe-shaped electromagnet, a rotating armature, a brush plate, and a reversing switch. The armature is fitted at one end with a small gear and at the other with a commutator made of three heavy copper segments. The current flows through the winding on the stationary magnet and also through the winding on the armature by way of the brushes, which make sliding contact with the commutator. In the finest motors, one of the brushes is of a graphitic carbon composition and the other is of tightly rolled copper gauze.

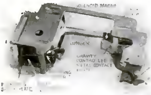
FOR reversing, a switch changes the direction of current through the armature with respect to the stationary magnet. In consequence, the magnetism in the armature is reversed in polarity and it rotates in the opposite direction.

The rollers of the current collector must be kept clean and should be replaced after long continued use has worn grooves in them and roughened the surface so that a good electrical contact is no longer possible. Trouble is almost never experienced with the stationary magnet, except perhaps a loose connection at a terminal wire.

Though the armature winding also gives no trouble, once in a while one of the wires soldered to the commutator segments will come loose. When this happens, the motor loses almost all its power and there is severe sparking at the brushes. The simplest remedy is to replace the armature with a new one; but if you are handy with the soldering iron, you can locate the loose connection and resolder it.

The condition of the brushes and the way they make contact is of vital importance. Whenever you find that a motor runs well in one direction but not so well in the other, the trouble is almost surely in the brushes.

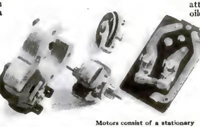
The best way to clean the commutator is to use a clean rag on the end of a small wooden stick. Give the commutator a wipe after every few hours of running and occasionally give it a thorough cleaning with a rag wet with gasoline. The gasoline sold in small cans for use in pocket lighters is especially good, because it evaporates clean and leaves no oily residue.



The reversing mechanism showing solenoid, plunger, cam mechanism, and switch plate.

READERS who have model railway problems about which they wish advice may write to Mr. Ryder. Address your letters care of POPULAR SCIENCE MONTHLY, 381 Fourth Avenue, New York.

Wheels, axles, and bushings can be lifted out as a unit when the collector plate is removed.



Motors consist of a stationary horseshoe electromagnet, armature, brush plate, and switch.

Never, under any circumstances, put any oil on the commutator. It should be operated absolutely dry. The carbon brush contains sufficient graphite to afford proper lubrication.

In the latest types of model locomotives the brushes are held in their tubular containers in such a way that they cannot rotate. In consequence, they quickly wear to a perfect fit against the commutator.

In general, if the motor runs poorly with but little hauling power, the trouble is most likely to be a dirty commutator. If the locomotive refuses to run at all or runs in a very jerky fashion, look for a broken or loose connection somewhere in the wiring or for a worn-out brush or broken brush spring.

The latest thing in model electric locomotives is a motor built so that it can be taken completely to pieces in a few minutes by the aid of an ordinary screw driver. Obviously, the new motors are much easier to clean and repair than the older types. Loose connections are almost an impossibility in these new motors, because all necessary connections are made by way of rigidly attached brass bus bars and spring plungers.

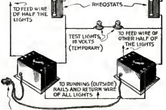
The more expensive grades of model electric locomotives are fitted with automatic reverse mechanisms. This mechanism may be removed as a unit from one of the new type locomotives. A solenoid electromagnet pulls a lever into engagement with a cam mechanism in such a way that the reversing switch plate is thrown alternately first one way and then the other.

Current from the third rail through this solenoid magnet is controlled by a contact on the end of a flat metal plate so hinged that gravity, when no current is flowing through the motor, pulls the heavy end of the plate down and closes the contact.

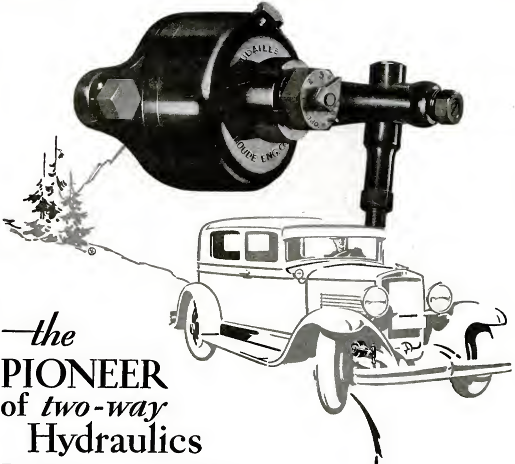
When the current is turned on, the pull of the solenoid reverses the switching plate and immediately thereafter the magnetism of the stationary magnet of the motor pulls down the contact end of the metal plate and stops the flow of current through the solenoid. When the current is shut off to stop the locomotive, gravity swings the metal plate back against the contact so that the solenoid will function when the current is again turned on.

The reversing mechanism requires no attention whatever. It should not be oiled at all. If your locomotive develops the unpleasant habit of suddenly reversing itself, or the reverse mechanism seems to falter and stutter, look for trouble with the commutator or collector rollers. The reverse mechanism cannot function properly if the current flow is interrupted at frequent intervals by a dirty commutator or worn collector rollers. Each time the current is interrupted the effect is exactly the same as if you deliberately shut the current off by means of the regular control switch.

Additional suggestions on the maintenance and operation of model railways, particularly with respect to lubrication, will be given in the next issue.


INSULATE THIRD RAIL INTO SECTIONS WITH FIBER PINS
TO THIRD RAIL OF ONE SECTION
TO THIRD RAIL OF OTHER SECTION
RHEOSTATS
TO FEED WIRE OF HALF THE LIGHTS
TEST LIGHTS, 18 VOLTS (TEMPORARY)
TO FEED WIRE OF OTHER HALF OF THE LIGHTS
TO RUNNING (OUTSIDE) RAILS AND RETURN WIRE OF ALL LIGHTS
IF TEST LIGHTS GLOW, REVERSE CONNECTIONS OF ONE OF THE CORDS TO THE PLUG TERMINALS

Test lights for determining phase relation in lines of two parallel connected transformers.



—*the* PIONEER of *two-way* Hydraulics

TWO-WAY spring control—down and up—is the principle pioneered, developed and perfected by Houdaille. For 27 years Houdaille Hydraulic Double-acting Shock Absorbers have been demonstrating to the motoring public the measure of true riding comfort.

Appreciation now amounts to demand and today the Houdaille principle is the standard of spring control. During the 27 years of Houdaille Supremacy these exclusive essentials have been perfected.

1. The double or balanced piston.
2. The reservoir which automatically replenishes the fluid.
3. The air vents which permit the escape of air and make the instrument truly hydraulic.
4. The easy single dial external adjustment.

Houdailles are standard equipment on Lincoln, Pierce-Arrow, Jordan, Ford, Stearns-Knight, Nash Advanced Six, Chrysler Imperial, Studebaker President, Graham-Paige, Cord front drive and many European cars.

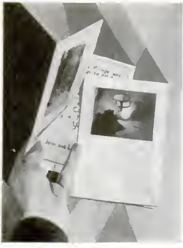
New low prices—$40, $50, $75 and $100 plus installation. Slightly higher west of the Rockies and in Canada.

Houde Engineering Corporation, Buffalo, N. Y.
DIVISION OF HOUDAILLE-HERSHEY CORPORATION

HOUDAILLE *hydraulic double acting* Shock Absorber

Christmas Cards *by* Photography

By JOHN STEINKE



Individualistic, photographic cards that can be made as formal or as informal and personal as is desired.

FOR individual Christmas greetings, photographic cards are ideal in that they can be made to reflect the sender's personality. One need not be expert in using a camera to prepare these cards since the photographic work can be done by a commercial photographer and finisher.

Either a plain card or a folder may be used. In designing, the aim is to bring the elements of lettering, color, and paper to form a harmonious whole that is characteristic of the sender.

Pictures have an especial place on a photographic card. Winter scenes are the most popular, but it should not make much difference what is used providing you link your wording with it and the festival occasion of the holidays. Take any scene that appeals to you and write the greeting around the picture. That is, make up your "copy." The secret of individualistic copy is "Be yourself." Do not be bound by convention. Write as if you were sending a letter or talking to a friend. The more nearly it is like you, the more personal will be the effect.

When your picture has been selected and the copy written, consider the arrangement of the card. Make "dummies" of common paper the exact size and kind of the intended card. On these sketch the layout of picture, wording, borders, and decorations. Make the dummies over and over until you arrive at an arrangement that satisfies you.

PLACE the picture first, then the wording, and last the border if you are using one. Keep the arrangement simple. If you find yourself temporarily stumped, look through a number of national advertisements and you will probably find a layout in one of them that will help you.

As soon as the layout is satisfactory, you are ready to do the actual work of making the card. It is necessary to prepare a large size card which you will later copy with your camera or have a photographer copy for you. This card should be a thin, smooth board. On it glue an enlarged picture and do the necessary lettering, if the card is to be a plain one. If you are making a folding card, the board will have only the lettering. This large card should be from three to five times larger than your finished card so that all imperfections will be reduced when it is copied.

By careful planning, anyone can do a fair lettering job. It is possible, however, to write out your greeting with a lettering pen so that when it is copied it will look as through you have actually written a personal letter. When lettering, keep the tops and bottoms even and in line. Keep the letters very close together and use uniform spaces between the words. Work to a center line. If you intend to color the initial letter, outline it; do not fill it in solid. In the case of handwriting, write as you always do.

Applying a spatter effect by running a knife blade across a toothbrush previously dipped in water color.

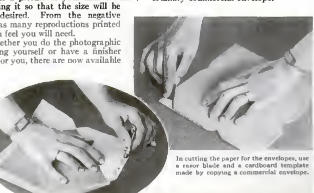
Take a picture of your finished card, reducing it so that the size will be that desired. From the negative have as many reproductions printed as you feel you will need.

Whether you do the photographic printing yourself or have a finisher do it for you, there are now available a number of interesting photographic papers, some with soft, dull surfaces and others with extremely brilliant surfaces like sparkling snow in sunlight. Still other papers can be had in gold, silver, and some colors. If you are making an all photographic folder, you must make certain that you use a photographic paper that folds without cracking.

AFTER printing, you may want to tone and color the prints. The redeveloping tubes are advised for the toning, while a brilliant color effect for the lettering part can be made by putting on a spatter color. Dip an old toothbrush into water color and draw a knife across it. This splatters the color over the print. Red and green, the Christmas colors, are especially effective.

Trimming the cards is all that remains to be done, if you are making plain cards. If a folder is being prepared, use any of the various thin mounting papers, and fold and mount your prints, tipping them on with glue.

You can buy many styles of attractive envelopes or make your own, if you prefer. For a pattern, open up an envelope of the style you wish to make. From this you can easily prepare a template. Lay out the template on heavy cardboard and use this as a guide for cutting the paper with a razor blade. Many attractive patterned tissue papers are available for a lining. Fold the envelope over a cardboard of the inside size of the envelope. Put points of glue along the edges and fold down. After the greeting is inserted, glue the flap in the same manner that you would use in sealing an ordinary commercial envelope.



In cutting the paper for the envelopes, use a razor blade and a cardboard template made by copying a commercial envelope.

The lining is placed in the envelope blank and then the three sides are glued and folded over.

S. W. GILFILLAN

President of GILFILLAN BROS., Inc. Says:

Look for this mark on every Radiotron

"Our advice to all of our dealers is to recommend RCA Radiotrons for initial equipment and for replacement in all of our radio instruments. We do this because we use them for experiments and tests in the Gilfillan laboratories and find that they have no superior."

S W Gilfillan

Expert radio engineers advise that all tubes in your radio set be replaced at the same time—once a year at least. Old tubes left in impair the performance of the others. By installing a complete new set of RCA Radiotrons you are assured of balanced performance.

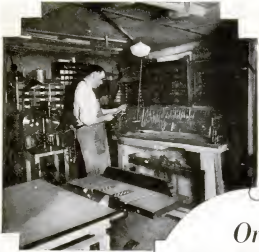
RCA RADIOTRON

RADIOTRON DIVISION

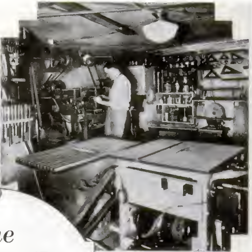
RADIO-VICTOR CORPORATION OF AMERICA NEW YORK CHICAGO ATLANTA DALLAS SAN FRANCISCO

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

One Man Who Has Every Tool a Woodworker Needs



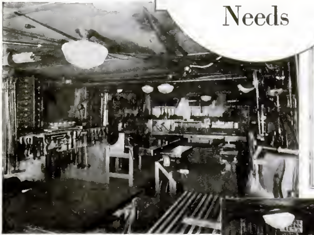
Benjamin C. Evans, of Crawfordsville, Ind., at the metal working bench of his extraordinary home workshop. A mortgage loan broker by profession, he has made mechanics, particularly woodworking, his hobby. In the foreground is the hollow chisel mortiser and boring attachment of his variety saw; behind this is an electric drill press and supply cabinets.



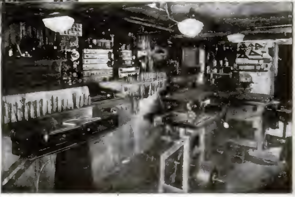
For jig-sawing, Mr. Evans uses a portable machine placed on the bed of his wood-turning lathe. At the right is a 12-in. sanding disk. The larger machines are a 12-in. drum sander and a circular saw table. All the machines in the shop are motor driven, three 1-H. P., two ½-H. P., and two ¼-H. P. motors being required to operate the entire shop.

WHAT amateur mechanic can look at Mr. Evans' workshop without a feeling of envy? Yet even if most of us cannot hope to have a shop so well equipped, we can emulate Mr. Evans in selecting only high-grade tools and machines, and in arranging them in an efficient and orderly way.

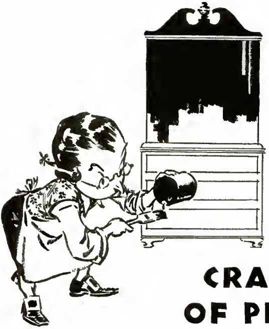
Even if your workshop is relatively small, you may have devised some special features that would interest other readers. If so, send a photograph or photographs, accompanied by a brief description, to the Home Workshop Editor. Five dollars will be paid for each print that is found sufficiently interesting for publication.



A general view of the shop which shows both the amazing variety of tools and the orderliness of their arrangement. All the cabinets are filled with tools and supplies. The revolving cabinet at the left holds seventy-two sizes of wood screws. In the center is a 12-in. band saw and immediately in front of it may be seen a reversible shaper, for which Mr. Evans has a large collection of cutters, an adjustable gage, and a hold down. In the background is a woodworking bench.



At the left is the jointer, in the center foreground the shaper, behind it the drum sander, and in the right background the variety saw table. Behind the jointer is a rack for bits; above is a tool cabinet, a collection of C-clamps and oilers, and a board with a number of shaper cutters and attachments. To the right along the wall is a rack for turning chisels, with cabinets above, and in the corner is the lathe and jig saw. A cabinet for paints, another for hardware and supplies, and a board for drafting instruments can be seen on the far wall.



THE CRAFTSMANSHIP OF PHINEAS PIGGE

THE mellow beauty of Early American cabinetry was born not without its trials. Phineas Pigge, personifying the traditional wood worker of Colonial times, was, after all, a human being. Picture, then, his consternation on the day he ran out of stain half-way through Col. Eustace's highboy. Nothing to do but mix more stain. And woe betide him if he failed to match the shade of the previous batch. It was a wizard's task. Phineas very often failed. And even when he approximated the former color, there were still streaks and laps to contend with.

Today, we so admire the useful and the beautiful in Phineas Pigge's cabinet work that we reproduce it on all hands . . . and with success. Its physical proportions are not difficult to copy. And today we have the advantage of Johnson's Wood Dye . . . uniform to the last drop in the bottle, to the last bottle in the gross. Its clear, true color penetrates deeply, without streak or lap. Take it from ten different bottles on the same job—the result is always the same, uniform to the last degree.

May we send you our expert manual on wood finishing? Professional methods of obtaining the mellow beauty of Colonial cabinetry, regardless of the wood you use, are explained step by step. And the Johnson's Wood Dye and Finishes specified may be purchased at your hardware store. Send coupon today.

S. C. JOHNSON & SON
"The Interior Finishing Authorities"
Racine, Wisconsin

JOHNSON'S WOOD DYE

S. C. JOHNSON & SON, Dept. (PM12), Racine, Wisconsin

Gentlemen: Please send me, without charge, your professional wood finishing manual.

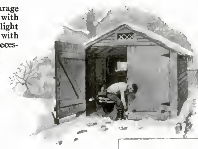
Name..

Street ....

City.................................*State*..................

How to Fix a Balky Garage Door

A Spray Gun for Oiling Hard-to-Reach Places—And Other Helpful Suggestions for the Automobile Owner



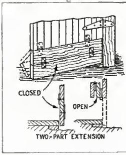


Fig. 1. A hinged section at the bottom of the door assures clearance in winter. Right: Diagram showing double hinge.

WHEN the runway to the garage is practically on a level with the garage floor, even a light fall of snow will interfere with opening the doors the full distance necessary to allow the car to drive out of the garage. Furthermore, if the approach to the garage is of concrete and the clearance is small, water getting under the concrete will freeze and lift it enough to jam against the bottom of the doors.

The illustration of Figure 1 shows one remedy. The bottom of the door is sawed off and replaced with a hinged section which can be turned up to give the door several inches clearance. If the door rests against a sill which extends across the front of the garage it will be necessary to make the hinged portion open outward, in which case the snow and ice will have to be shoveled away for an inch or two in front of the doors to permit the folding up of the lower portion, as shown.

The diagram of Figure 1 shows another method of solving the problem by replacing the lower portion of the door with a double hinged section which can be folded straight up. This avoids all trouble with ice or packed snow unless, of course, the snow is piled higher than the top hinge.

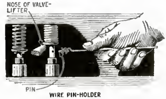


Fig. 2. Replacing a valve pin with the aid of an ingenious holder made of looped iron wire.

Simple Holder for Valve Pin

MANY jobs around an automobile are hard to do, not because they are inherently difficult from a mechanical standpoint, but because space is so limited that the hand cannot properly approach the work.

One operation of this sort is that of replacing the valve pin after the valves have been ground. With some types of valve lifters it is very difficult to hold the pin between the fingers and get it in the hole in the valve stem. Frequently part of the manifold or some other portion of the motor interferes with the hand. Figure 2 shows a simple remedy. Wind a wire pin-holder of iron wire. Make the loops in the end of the wire just tight enough to properly guide the pin and loose enough so that the holder can be withdrawn, leaving the pin in the hole in the valve stem. The pin will stay in the hole and pull out of the pin-holder if the holder is moved sidewise to cramp the pin in the hole.

Handy Squirt Lubricator

THE harder it is to get at a bearing to lubricate it the more likely is the lubrication to be neglected. While the modern automobile is so constructed that lubrication is as easy as possible, there are many places that still are hard to reach, such as the clevis joints in the brake mechanism.

Few people like to crawl under a car just to squirt a drop of oil or two from an oil can on a clevis joint. Figure 3 shows how to avoid this trouble. Secure an old discarded plumbers' torch and remove the wick. Fill it with a mixture of light lubricating oil to which a small percentage of kerosene has been added. You will find that if you pump up a good pressure you can, with this outfit, squirt a fine stream of oil as far as fifteen feet. A little "target practice" at the clevis joints and springs will materially reduce the wear and consequent rattle at these points. Squirting oil along the edges of the spring leaves is easy, and adequately lubricates the spring.

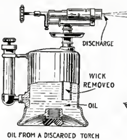


Fig. 3. An old plumbers' torch converted into a spray gun for oiling places hard to reach.

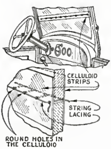


Fig. 4. Right: How to replace the rubber strip across the windshield with celluloid.

Windshield Gap Closer

MANY open cars are so constructed that the windshield is in two sections. Usually a rubber strip is supplied to fit in between the two sections to keep out the rain. This strip, while effective in keeping out the rain, does not improve the car's appearance and is a disturbing black line across the line of vision.

An effective solution of the problem is shown in Figure 4. Two strips of transparent celluloid, in length equal to the width of the windshield, are perforated along their center lines with a series of holes. They should be laced in place as shown in Figure 4, pulling the lacing sufficiently tight to keep the celluloid flat against the glass.

$10 for an Idea

EACH month POPULAR SCIENCE MONTHLY awards a prize of $10, in addition to regular space rates, for the best idea sent in for motorists. The winner of this month's prize is D. L. Siverd, of Commodore, Pa., who suggested the garage door clearance device in Figure 1. Other contributions published are paid for at the usual rates.

TUNE IN!

ERNO RAPEE *and the* MOBILOIL ORCHESTRA

of 55 pieces every Wednesday night over W E A F and associated N B C stations.

We asked:

"What do you notice first about the New Mobiloil?"

Motorists answered:

"It lasts longer"

When the New Mobiloil had been in use several months, we sent investigators to call on motorists in different parts of the United States and Canada. We wanted their unbiased opinion of this new oil.

Our investigators asked: "What do you notice first about the New Mobiloil?" Motorists everywhere answered: "*Mobiloil lasts longer.*"

What is the significance of these three words "Mobiloil lasts longer"? Perhaps they sound unimportant at first glance. But as a matter of fact, they are the most significant words in the science of lubrication. For, in comparing oils of similar "body", engineers have proved that the oil which lasts longest, also lubricates best.

Of course, we already knew the New Mobiloil was the longest-lasting oil on the market. We had given it every scientific and practical test we could devise.

Through all hours of steady speedway driving at an average speed of nearly 70 miles an hour, we conclusively proved that the New Mobiloil stands up better and lasts longer under every speed and condition of driving.

This is why we can say to you: "The New Mobiloil will keep the first-year feel in your engine, lubricate your engine better—it lasts longer."

VACUUM OIL COMPANY

Makers of high quality lubricants for all types of machinery

the New

GARGOYLE

Mobiloil

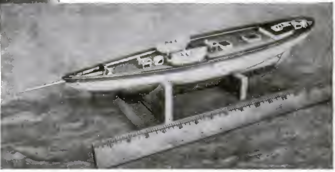
Keeps the first-year feel in your engine

Furnishing the *Bluenose* Deck

Second Article in a Series on Building a Schooner Model—Blueprints Are Available with Complete Full Size Drawings

By E. Armitage McCann

Fishing schooner model *Bluenose* built by Captain McCann, master mariner and ship model expert.



The fittings, as shown, are correct in every detail and the accuracy with which they are made and arranged does much towards making the model an attractive and perfect miniature.

For those who are thrilled at the mention of the sea, the building of this small-scale reproduction of the famous fishing schooner *Bluenose* should prove to be an interesting and pleasant pastime.

If you missed the first of these articles (P. S. M., Nov. '29, p. 79), which dealt with the construction of the hull, you can obtain full size drawings of the completed model with details of each difficult part by sending for Blueprints Nos. 110, 111, and 112 (see page 110).

Having completed the hull, we are ready to fashion and arrange the deck fittings. These operations should particularly interest those who love the sea, for in planning the deck our imagination can carry us to the original *Bluenose* with its spray-spattered deck and rails.

The fittings and their respective places in the deck grouping are shown below.

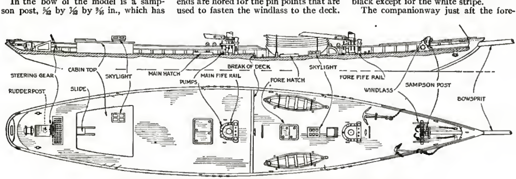
Hawse holes should be placed in the hull by boring 1/8-in. holes in such a way that they come through the deck at an angle just inside the waterways. A rim can be added by using gesso or other plastic material.

In the bow of the model is a sampson post, 5/32 by 7/32 by 3/16 in., which has a square hole in the base to take the bowsprit. Near the top, on the forward side, is pivoted the arm for the windlass brakes, and above this is the bell, which can be made from a pin and a drop of solder filed to shape.

The windlass barrel has wide cogs in the center in which the pawl catches, small cogs for the ratchet of the brakes, curved barrels for the chain, and a smaller drum for the ropes. The uprights can be cut to shape, bored for the barrel, then split with a knife and glued together again around the bearings. The extended ends are bored for the pin points that are used to fasten the windlass to the deck.

There are eight 1/8-in. deadeyes on each side of the hull as shown in the deck plan. The forward ones are level with the masts at the deck level and are set close to the rail cap at 1/4-in. intervals. The deadeyes are held down with chain plates having no channels. They can be made by twisting fine wire around the deadeyes, leaving short ends slightly apart. Cut 3/32 by 1/2 in. strips of metal, punch two holes in them, and solder on the ends of the wire. Then cut notches in the rail caps and nail the plates to the hull with hank pins. The chain plates are painted black except for the white stripe.

The companionway just aft the fore-



Plan showing position and comparative size of fittings. A *Bluenose* history can be obtained by sending a self-addressed and stamped envelope with a request for Home Workshop Bulletin No. 2.

» AN AMAZING IMPROVEMENT IN RECEPTION FROM YOUR PRESENT RADIO RECEIVER «

WITH NEW EVEREADY RAYTHEON 4-PILLAR TUBES ®

THE inevitable jolts and jars of shipment and handling can't budge the elements in an Eveready Raytheon Tube by as much as a thousandth of an inch. Their accurate spacing, which assures maximum performance, is immune to these common hazards.

4-PILLAR TUBES

Showing the exclusive, patented Eveready Raytheon 4-*Pillar construction.* Notice the sturdy four-cornered glass stem, the four rigid supports, and the stiff mica sheet bracing the top.

The 4-*Pillar construction,* which gives Eveready Raytheon Tubes their remarkable strength, is patented and exclusive. With no other tube can you get all its advantages. If you examine the illustration at the bottom of this page, you will see the superiority of this construction.

This is especially important in receiving tubes which have large and heavy elements—tubes such as the 224 screen grid, the 280 rectifier, and power tubes used for push-pull audio amplification, requiring perfectly uniform characteristics.

People everywhere, using Eveready Raytheons in their receivers, report increased distance, more power, better tone and quicker action. To get the most from *your* receiver, put a new Eveready Raytheon in each socket. Your dealer has them in all types—including the famous B-H tube for "B" power units.

NATIONAL CARBON CO., Inc.
General Offices: New York, N. Y.
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New York San Francisco
Unit of Union Carbide UCC *and Carbon Corporation*

4-PILLAR SCREEN GRID

Eveready Raytheon Screen Grid Tube, ER 224. The weight of the four large elements in this type of tube makes the exclusive Eveready Raytheon 4-*Pillar construction* vitally important.

EVEREADY RAYTHEON

Trade-marks

This seal o … oval of th

mast is a block of wood, cut as shown, the front having a door and the sides being paneled. It is white with a brown door and panels.

The skylight aft the companionway is above the galley; it, too, is fashioned from a block of wood and painted white. The six small squares are glass, for which celluloid or photographic film may be substituted.

The fore and main hatches are blocks sloped slightly on top and rounded at the corners, with grooves in the top and tiny ringbolts made from wire rings fastened down with little staples. The coamings are white and the hatches dark brown.

The cabin top is also made from a block of wood, the side lines conforming to the run of the rails. On it, to one side, is a skylight somewhat similar to the one forward. At the after end are doors and a slide. The top, which overhangs the side a little, is painted brown, while the sides are painted white.

The steering gear is a worm and screw affair inclosed in a box as shown. The shaft of the wheel lies to one side of the rudderpost and is at right angles to it, therefore not horizontal.

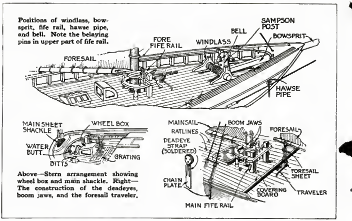
The wheel may be cut from brass plate or celluloid, or made from wood with brass wire spokes soldered to a hub and shaft.

Aft of the wheel is the water butt, which is a cask shaped from a piece of wood and lashed to two cleats glued to the deck. A pinhead will serve as the bung. The cask cleats and lashings are all painted white.

On either side of the wheel are the mainsheet bitts, which are nothing more than posts with pieces of flat metal driven through them.

The grating is a delicate thing to make properly. The best way is to take a thin piece of hardwood and make saw cuts halfway through, where the crossbars are to be; then make long cuts lengthwise, cutting through where the holes are to be. Cut strips of wood to fill the cross cuts, glue them in, and sandpaper smooth. The grating effect may be simulated, however, by varnishing the wood and drawing in the holes with India ink.

Two nests of six boats each are carried by the *Bluenose*. Each nest is made in one piece by cutting it to the main outline, cutting V-shaped grooves at the sides and ends, and hollowing out the upper dory and giving it three seats and little stem and stern seats. These nests are lashed to cleats fastened to the deck and at least the upper ones should have a loop of rope at each end to facilitate lifting the boat outboard. The boats are brown outside and white inboard.



Positions of windlass, bowsprit, fife rail, hawse pipe, and bell. Note the belaying pins in upper part of fife rail.

Above—Stern arrangement showing wheel box and main shackle. Right—The construction of the deadeyes, boom jaws, and the foresail traveler.

The holes for the masts and bowsprit next can be bored. The ⅜-in. hole for the bowsprit will have to be very carefully made. A small hole should be drilled first and then a larger one made.

The hole for the foremast, $\frac{5}{16}$ in. in diameter, is 4¾ in. from the stem; the hole for the mainmast is 4½ in. farther aft. The foremast rakes back at an angle of two in fifty, the mainmast at three in fifty.

The fife rails surround the masts. The forward one may be a shade smaller than the main. Glue two square posts into the deck forward of the mast as shown; to these fit a D-shaped piece for the rail, supported abaft the mast by turned posts. Then make an oblong piece with square holes in it to fit over the forward posts. On the outside of each post there is a cleat which should have a sheave (wheel) in it; pins hammered flat will serve for these.

Belaying pins are held in these rails as shown, eight in each. These may be turned from brass wire or bought ready made, or plain pins may be used. Paint the rails and pins white. Almost under the main fife rail are the pumps.

To the little bulkhead at the break of the deck and to the deck forward of the foremast are fastened cleats for the foresail and staysail sheets. Nail as well as glue them because they have to stand a strain.

Right aft, at the position shown, are the main sheet shackles (see detail). The shackles and rings project through a slot in a board, just under the level of the upper cap rail. All of this is white.

Our schooner will carry two anchors on the foredeck. One is a regular harbor anchor with a loose stock, as shown on the deck plan, the shank being about ¾ in. long. The other is a sand anchor for anchoring on the banks. It is longer and slenderer with wide palms. It will not be lashed down on deck like the other, so is lashed with half of its wooden stock overhoard, as with deep-sea ships. The heavy anchor has a short chain cable, the sand anchor a long one of rope or wire.

Next month we will proceed to set up the rigging on our schooner.

Preparing and Painting Concrete Floors

Many kinds of paint coatings for cement floors are now on the market and are very efficient in that they act as an attractive finish for the floor and also protect the surface to some extent against the ravages of wear in the form of powdering away and cracking.

In preparing a floor for a paint coat, care must be taken that the surface is free of any dirt or grease. Grease spots can be eliminated by scrubbing the floor with a strong solution of washing soda and water after first cleaning up as much as possible with benzene.

Cement floors are likely to show streaks of alkali. This coating should be removed or neutralized before the paint is applied. The best way to do this is to use a solution of four pounds of zinc sulphate dissolved in a gallon of water. If the floor is at all damp the zinc sulphate will not be effective in neutralizing the alkali, so it will be best to use instead a solution made by mixing one pound of fluosilicate of magnesium in one gallon of water.

Before applying the finishing coat in the form of paint, be sure that the floor has thoroughly dried, because any traces of the washing solution will tend to injure the painting coat. Also remove all crystallization from the surface, as the crystals will tend to cause cracks and scale in the paint. This can be done by brushing the surface thoroughly.

One type of coating is made of cement on a lime base. This is also used on stucco and concrete walls. As it must penetrate, it cannot be used on top of concrete previously finished with oil paint.

If a concrete surface is first prepared with any one of the standard cement surface hardeners, which will eliminate what is called "suction," any first-class floor paint or enamel will serve. There are on the market, however, several specially prepared floor paints of the oil and varnish base type that will give better service than the paints intended for use on wood floors only. Paints on floors are subjected to extremely hard usage and those covering cement floors even harder wear, since the cement does not offer the cushioning effect that wood does.

Cement floors can also be treated by applying one coat of surface hardener and then t [illegible] of floor wax.—G.W.

How to File Circular Saws

Told by the World's Foremost Makers of Saws

DISSTON Circular Saws, and all other Disston Saws, are made of Disston Steel, from Disston's own steel furnaces. The cutting qualities of this steel, and the skill of Disston craftsmen, made Disston the world's foremost saw makers.

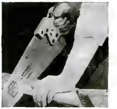
You want Disston Steel in your circular saw. There is no substitute for it. This steel takes and *holds* a keener cutting edge; cuts easier, and stays sharp longer. In great lumber mills, Disston Circular Saws are standard equipment. You will find that you, too, can do better work if you use only Disston Saws in your home workshop.

Ask for Disston! Circular Saws and Band Saws, Hand Saws, Hack Saws, and, of course, Disston Files.

Files for the Wood Worker

Disston Cabinet Files (fine teeth) for smoothing and finishing wood surfaces, easing tight doors and drawers, etc. Disston Wood Rasps (coarse teeth) for rough and fast cutting, enlarging holes, etc. Half-round 8" Cabinet File, 65c. Flat 8" Wood Rasp, 50c.

A Disston Circular Saw on a Portable Bench Machine



"The Saw Most Carpenters Use"

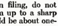
The two handiest saws for the home workshop are the 26-inch 8-point for cross-cutting, and the 26-inch 5½-point for ripping. You will need these on almost every job. The popular "D-8" Lightweights cost $3.45. Many other styles and sizes to choose from.

Handiest of Pocket Levels

For truing up construction work, levelling shelves, etc., use a Disston Featherweight Pocket Level. It is the lightest and handiest level made. Length, 9"; weight, 2 oz. Aeroplane aluminum. Three proved glasses. $1.25.

TO sharpen small circular saws, you need a filing clamp or vise; the proper files, and a saw set, or an anvil and hammer, to spring the teeth. The Disston No. 7 Circular Saw Filing Vise is handiest, taking saws from 4" to 16". On cross-cut and combination saws, use Disston Taper Files, 6" or 7"; on circular rip saws use Disston Mill Files, 6" or 7", with one round edge.

First joint the saw, getting all teeth same length. Do this by turning saw backward by hand on mandrel, holding emery stone lightly against tops of teeth until all are touched.



Then put saw in vise and set the teeth, using a Disston No. 18 Triumph Saw Set (Illustrated; $1.50). Be careful not to carry the set down too far on the teeth. Follow the original set of your saw. Note that one tooth is set to the right and the next to the left.

Next file the teeth as near to their original shape as possible. Keep all gullets of same depth and width. Bevel teeth alternately, following original angles. In filing, do not reduce length of teeth: simply bring them up to a sharp point. Bevel on both face and back should be about one-third the length of the teeth.

On a combination novelty saw, which cross-cuts, rips, and miters, do not set the raker teeth; set only the scoring teeth. No teeth of a hollow-ground combination saw should be set. Do not bevel raker or cleaner teeth, but file them straight through.

Your hardware dealer has in stock, or can get for you quickly, Disston Circular Saws for any machine.

Band Saws for Better Work

Disston "Thin Gauge" Narrow Band Saws are 2 to 3 gauges thinner. They run better on machines with wheels up to 26" diameter. Saw 9' 8" long, ½" wide, 25-gauge, brazed, $2.03. Other sizes in proportion.

For Cutting Dovetails, etc.

Wherever the finest possible joint is needed, and for dovetailing, pattern making, etc., use a Disston No. 68 Dovetail Saw. Blade extra thin, with fine teeth. The 8" blade, 17 points to inch, is most popular. $1.60.

DISSTON

Makers of "THE SAW MOST CARPENTERS USE"

Disston Combination Saw

This type of Circular Saw, known as a Combination Novelty Saw, does cross-cutting, ripping, and mitering equally well. It is made either flat ground for general work or hollow ground for smoother cutting.

"Disston Small Circular Saws and How to Use Them" is a new bulletin which tells how to operate and refit saws. It will be of interest and value to every owner or prospective owner of a small electric bench saw outfit. The coupon will bring it to you.

Henry Disston & Sons, Inc., Philadelphia, U. S. A.
(In Canada, address Henry Disston & Sons, Ltd., Toronto)
Please send Bulletin on Circular Saws and other helpful data.

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Hints on Heat Treating Steel

How to Acquire Instrument-Like Accuracy in Judging Hardening Colors—Tricks in Controlling the Process

By HENRY SIMON

WHEN a mechanic is familiar with the theory of hardening tool steel (see P.S.M. Nov. '29, p. 94), he naturally asks two questions: How can I obtain the necessary practice in judging the hardening colors? What is the best method of arranging the equipment and carrying out the operations used in hardening? This article will give new and simple answers to both questions.

To obtain practice in judging colors, it is well to use a number of graduated test pieces, as shown in Fig. 1. These may be made from tool steel odds and ends, but all should be of the same steel, with the kind of steel identified by a stamped number. Ordinary drill rod is an excellent material because it requires no cleaning and will harden in both water and oil.

Start with two dozen small pieces, all of the same size and shape as at *A*. Heat one piece at a time, attentively watching for the change, and quench in water just as the piece seems to gain color again. Test the hardness with a file, as suggested at *B*. If it is so hard that the file will not cut it, try quenching the piece at what you consider a slightly lower temperature. Test again, and continue going down with successive pieces until the file just cuts with difficulty. A shade above this is the proper quenching temperature.

When about half the pieces have been hardened in water, try the remainder in oil. This time the "heat addendum" is a little harder to judge, because it starts about 100°F. above the end of the critical range. Remember that, other things equal, it is not possible to get the same steel quite as hard in oil as in water or brine. Although it is poor practice to harden steel more than once, it will be all right to use such test pieces over again three or four times, provided they are cleaned with coarse aloxite cloth before each use.

With a few hours of steady systematized practice you will be able to judge just when the critical change takes place. It then remains to develop the judgment necessary for determining the heat allowance for work of various sections. Here again, practice may be made short and cheap by making up several sets of graduated trial pieces, something on the order of those shown at *C*. Follow the same procedure as before, and it will not be long until the eye will have obtained a fair judgment of what the proper quenching heat for any particular piece of work should be.

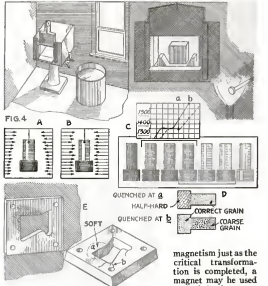


Fig. 3—*A*. Wrong oven position. *B*. Oven placed in dark corner. Fig. 4—*A*. Uneven heating caused by poor distribution. *B* Uneven heating resulting from fast heating. *C*, *D*, and *E*. The serious results of uneven heating.

Since steel loses its magnetism just as the critical transformation is completed, a magnet may be used as a help in ascertaining it. With proper handling, this point can be determined with all the accuracy of a costly instrument, as indicated at Fig. 2-*A*. At *B* is illustrated a more convenient device—a small bar magnet hung from the end of a brass rod. As the steel emerges from a black-red heat and begins to brighten, the magnet is repeatedly approached, each time being quickly withdrawn, until it is found to be no longer attracted. Such a magnet is a valuable aid to the beginner, and indeed is always a good check to have on hand. It should, however, be used only as a check.

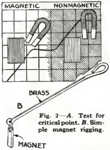


Fig. 2—*A*. Test for critical point. *B*. Simple magnet rigging.

Learning to harden by eye is a meaningless term, however, unless the eye is given a fair chance to tell heat color. This means, for one thing, that the oven must be shaded as carefully as a lathe or miller should be lighted. The oven should be located in some corner of the shop where the light is subdued. Glary, whitewashed walls and unshaded windows near the oven, such as in Fig. 3-*A*, should be absolutely avoided.

As indicated at *B*, there should be nothing to distract the eye, no matter whether an oven or a flame is used for hardening. As the critical range is approached, the eye should be kept confined to the fire and the shaded surroundings. Last but not least, light conditions must be right in the oven itself.

This part of the problem will take care of itself when the heating is correct. Generally speaking, heating is right when it is slow and uniform. When a cold oven is so heated, all parts of the interior will redden evenly. The appearance of a fiery fog when the oven is at or near red heat may be evidence of either incomplete combustion or of too fast heating. When properly

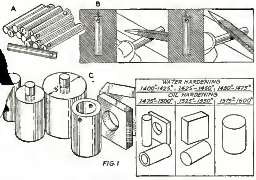
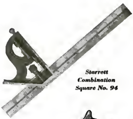


Fig. 1—*A*. Drill rod samples. *B*. Testing for hardness with file. *C*. Various graduated test pieces, and table showing differences in water and in oil quenching.

not just making things . .

Starrett Dividers No. 92

Starrett Micrometer No. 320



Starrett Combination Square No. 94

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NOT just making things, but making them right—that's the big kick you get out of your shop down cellar when you work with Starrett Tools.

Each of the Starrett Tools shown here—and many another besides—should be in your tool-chest. They are accurate, practical, dependable.

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fired, the atmosphere in the oven should be entirely clear by the time the oven walls first begin to show color, and it should remain clear throughout the heating. When thus heated, the quenched work will show no appreciable amount of scale or carbon deposit, and it will be in a condition to allow the eye to exercise full judgment.

Properly done, the heating should ordinarily produce a simultaneous temperature rise in all parts of the work. Uneven heating may be of two kinds, that due to defective heat distribution in the oven as at *A*, Fig. 4, and that resulting from too rapid heating, as at *B*, where the heat in the oven is uniform, but the slender portions of the work cannot carry off the heat at the same rate as the heavier ones. Often the one trouble is due to the other, because the forcing of the fire causes the oven to heat unevenly. Whatever the cause, the effect is equally bad; some portions of the work go through the critical change at an earlier moment than the others, as seen at *C*, and are therefore bound to be above or below the proper quenching temperature at the moment when the remaining portions are right.

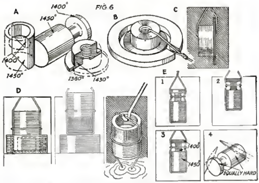


Fig. 6.—A. B. and C. Odd shapes require special heating. *D.* Method of quenching to overcome uneven hardening. *E* When shielding is impossible.

The results in this event are pictured at *D* and *E*. In the plainer kinds of work, such as the stud at *C* and *D*, there is the choice of either quenching at the temperature of the body and getting the head imperfectly hard, or of quenching at the temperature of the head and having coarse and weak grain in the body. The case is worse with the die at *E*, where there is a soft spot at *a*, weak grain and hardening cracks at *b*, and probably deformation of the die shape.

This brings us to a point which is generally little understood. While it may be entirely correct to introduce a piece such as the almost solid bar *a* in Fig. 5 into a red-hot oven, it will not on any account do to follow the same procedure with a piece having slender projections like *b*. Unless the fire is unduly forced, the work at *B* will be able to convey the initial high heat fast enough to the internal portions. With piece *b*, however, the thin portions are bound to flare up ahead of the heavy ends. These portions will therefore be hotter than the rest of the piece, and they will have been subjected to injurious soaking long before the piece is quenched. Such work should therefore be slowly brought up from a black or black-red oven, as indicated at *C*. It is certain evidence of heating if a thinner portion of a piece shows even a slightly higher heat than the rest.

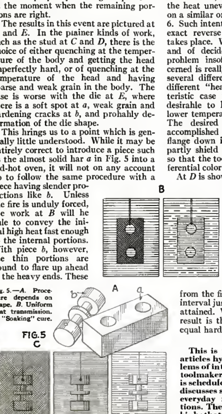


Fig. 5.—*A.* Procedure depends on shape. *B.* Uniform heat transmission. *C.* "Soaking" cure.

With pieces on the order of *b*, it is, nevertheless, desirable at times to apply the heat unevenly. Several more pieces on a similar order are shown at *A* in Fig. 6. Such intentional uneven heating is the exact reverse of that which ordinarily takes place. Where a part is of some size and of decidedly varying section, the problem insofar as quenching is concerned is really the same as if there were several different parts each requiring a different "heat addendum." A characteristic case is illustrated—where it is desirable to heat the thin flange to a lower temperature than the heavy body. The desired result can be properly accomplished by placing the tool with the flange down in a shallow ring that will partly shield it from the heat, as at *B*, so that the tool in quenching shows a differential color something like at *C*.

At *D* is shown a similar plan applied to part *a*. Such a part with a blind hole, by the way, should be quenched so as to avoid uneven hardening. At *E*, finally, is suggested a simple rough-and-ready way that is sometimes useful in parts which cannot be conveniently shielded. This consists in removing the work partly or wholly from the fire several times for a brief interval just before the critical range is attained. With skillful handling, the result is the desired temperature and equal hardness of both portions.

This is the twelfth in a series of articles by Mr. Simon on shop problems of interest to the machinist and toolmaker. In his next article, which is scheduled for early publication, he discusses some odd uses for familiar, everyday materials in shop operations. These uses are incorporated in kinks that help to lighten many of the often difficult jobs around the shop.

Annealing Large Size Castings

Build a forge fire to the depth of 6 in. Break the coke up into small pieces, place the work on top of this, and build a fire-brick wall around it. Next, fill in the spaces between the wall and the work with small pieces of charcoal. Heat the material with a very light blast until the charcoal is fully ignited and keep the charcoal burning until the work becomes red-hot. Heat the work for about one hour and keep it well covered with charcoal. Then allow the fire to die down and the work to become cool slowly.—George Schmidt.

Old Bill *Says*—

You can saw to a curved line if you grind away about half the width of the hack saw blade between holes.

Doing good work is only half of being a good mechanic; taking care of machinery and tools is the other half.

Deep holes can be drilled better in the lathe than in a drill press; for as the work revolves the drill tends to go to the center, while if the drill is revolving it tends to move out.

To be sure you are right when grinding a reamer, try it in a piece of scrap metal and check the hole.

Do not depend on the toolcrib man too much; check all of your tools for size.

Punctuality is one of the most valuable assets a shop man can acquire.

Sometimes a file reversed in the filing machine will give better results, especially on thin work.

Loosen the chuck jaws when finishing a thin ring or it may not be round when you get through.

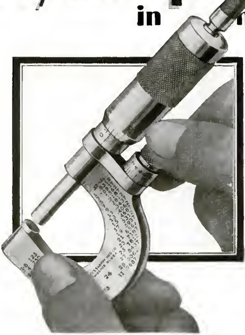
Grind a few grooves in a hardened set screw to use as a tap for cleaning out holes—as, for example, holes in a die that were packed during the heat treatment.

A small pocket mirror is a handy tool.

an entirely new principle in micrometers

No. 24

Range 0 to 1" by ten-thousandths of an inch.



A better way to read ten-thousandths

The new Brown & Sharpe Micrometer Caliper No. 24 measures direct by ten-thousandths in a new, easy way. Ten-thousandths can be read as easily and positively as thousandths on an ordinary micrometer. Notice the widely spaced graduations on the lower thimble where the ten-thousandths are read.

Compact in design, easily used, easily read—there are no gears or intricate mechanisms to get out of order.

Ask your dealer to show you this new micrometer or write for circular. Dept P. S., Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

B·S

"WORLD'S STANDARD OF ACCURACY"

BROWN & SHARPE TOOLS

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Shear Cutting

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PORTER'S
Portable
HAND CUTTING TOOLS

Porter's Cutting Tools are designed to save backaches and precious time. They are portable—for use wherever the job happens to be. Their rugged jaws cut clean, multiplying tremendously the pressure exerted on the handles. And they may be used in various positions, in spaces otherwise difficult — or impossible — to work in.

In production, maintenance and repair work Porter Tools multiply man power. They belong in every well-equipped shop, work bench and tool kit.

Send for illustrated booklet describing Porter Tools, their uses and economies.

Chain Cutting **Bolt Clipping**

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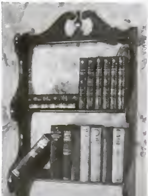
How to Operate a Jig Saw

By
WILLIAM W. KLENKE



These bookshelves form an ideal object lesson in the use of the jig saw.

THE curved outlines of these attractive hanging bookshelves make an ideal problem for studying the use of the motor-driven jig saw.

In earlier articles, the writer has told how to use many other home workshop machines, illustrating the processes in each case by some piece of furniture. The bookshelves chosen for the present example will prove an addition to the living room or den, or, indeed, may be placed in the breakfast room to hold artistic pieces of china or pottery.

In choosing the type of wood to be used, much depends on the finish. My choice would be a cheerful color of lacquer, agreeing with the color scheme of the room in which the shelves are to hang. Whitewood, or even wood taken from packing cases may be used, if close grained.

Step No. 1—Making the Patterns. On a sheet of heavy cardboard 5 by 31¼ in., lay off 2-in. squares, and from the working drawing on page 96 plot the curves. Cut along the outline with scissors. In like manner lay out and cut the headpiece on a sheet of cardboard 5 by 16¾ in.

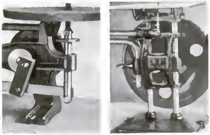
Step No. 2—Getting Out the Stock. On the jointer, join all edges of the various pieces—the two sides, the headpiece, and the three shelves.

Step No. 3—Using the Circular Saw. On the circular saw, rip the pieces to the correct width and again join these edges on the jointer. Cut the ends off square, making all the shelves the same length. If you have a shaper (shaping machine), use it for putting any desired molded edge on the front of all shelves. Of course, you can easily round these edges, as shown, with a hand plane.

The table of the jig saw can be tilted to any angle, making it easy to cut an accurate bevel.

The tension of the blade of this machine can be adjusted by working a lever at the top.

Step No. 4—Using the Jig Saw. Jig saws are constructed on two different principles. The one type works on a cam or eccentric, with a little handle or crank on the side of the wheel connected with the saw; and as this wheel revolves, the handle pushes the saw frame up and down. The maximum speed and power is possible with this type of construction. The second type is constructed with a horizontal sliding block or crosshead, which moves the saw frame



Two types of jig saw mechanisms. At the left is the crank motion and at the right the horizontal motion mechanism.

Gee, Dad! Couldn't We Have Fun with One of Those Chests!

A set of tools—what do they mean? To the boy—boats and airplanes and swords and heaps of shavings; to Dad—a workshop—hours of interesting recreation with his boy; to Mother—comradeship for her husband and boy—flower boxes for the sun porch—and maybe, repairs to the cupboard door.

Boys or men, the fascination is the same. *Why not a chest of Stanley Tools for them this Christmas?* There are ten different sets all packed in sturdy chests. From $10.85 to $90, there is one to fit every purse.

There are also twenty-five Stanley Plans giving step by step instructions how to make twenty-five useful household articles. The book, "How to Work with Tools and Wood," is a practical textbook and guide for tool users. Plans cost 10c each; book, $1.00.

Your hardware dealer will be glad to show you these tool chests. Ask him for a copy of Stanley Tool Chest Catalog No. S35e or send to us for a copy.

THE STANLEY RULE AND LEVEL PLANT
NEW BRITAIN, CONN.

STANLEY TOOL CHESTS

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Maydoles . . .

the big "feller"

for rough, tough work, balance, power and strength built in. Claws have a grip like a bulldog's jaw, pull the largest nail or smallest brad without slipping. Built to stand the hardest use.

the little "feller"

for model builders, radio fans—for delicate, fussy cabinet work. Perfectly balanced, face and sides crowned just enough so you won't mar your work, built for men who know tools and like to work with good ones.

If you take pride in your tools and the work you do, you'll want these Maydole Hammers in your set. Ask your dealer to show you the size and weight you like.

Write us for a free copy of Pocket Handbook 23 "B" containing much handy information.

YOUR HAMMER SINCE 1843

Maydole Hammers

The David Maydole Hammer Co., Norwich, N.Y.

Some types of portable jig-saw motors can be easily dismantled and effectively used as electric hand drills.

up and down by means of a crank mechanism. The action of this type is smooth-running and extremely quiet.

The table of the jig saw is set to an angle of 90 degrees in order to make a square cut. Insert a rather coarse blade in the frame, seeing that the teeth point down. Now adjust the finger for holding down the work to the proper thickness.

You will have to work in from both ends on account of the length of the sides; it may even be necessary to do a little hand work if your machine will not reach to the center from both ends. It will pay you to do the jig-sawing very carefully, as it will eliminate a great deal of handwork.

Step No. 5—Smoothing Up the Edges. Use a drum sander on all possible curves. Curves that are too abrupt for the sander must be smoothed with a cabinet file, followed with sandpaper. For some of the curves, a small spokeshave will help a great deal; and on the convex curves and flat pieces, a sharp chisel is the best tool to use. A good cabinetmaker uses the file as little as possible.

Step No. 6—Cutting the Dado Joints. Place the two sides together, being sure to have a right and left side. With a try-square, mark the location of the three shelves. Use a groover of the proper size and fasten this in the circular saw, 5/16 in. above the saw table. Groove out both sides. Note that the grooves do not run to the front edge; this means that you must raise the stock up so as to start cutting at the right mark. A little handwork will be necessary at this point. The end can best be cleaned out by boring a 1/2-in. hole with a Forstner type bit; make the holes 5/16 in. deep. The rounded front edge of the shelf will fit the hole perfectly. A simpler method, though not so good, for fastening the sides to the shelves, is to make butt joints and screw the job together with roundheaded screws.

Step No. 7—Turning the Ornament. Glue two pieces of stock together with a sheet of paper between, making a piece 1 1/2 in. square, and turn the ornament in the lathe. The purpose of the paper is to allow the splitting apart of the two pieces after the turning operation is completed.

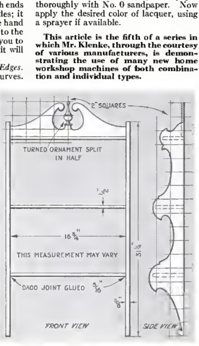
Step No. 8—Sandpapering. Using No. 1/2 sandpaper, thoroughly sand all parts. Repeat with No. 0 sandpaper.

Step No. 9—Assembling. Make a trial fitting between clamps to make sure that all joints fit. Mark the companion pieces as they are to go together. Use plenty of the best glue and clamp the work tightly. Clean off all of the excess glue by throwing fine sawdust over the glue that oozes out of the joints and then scraping it off at once with your chisel.

Step No. 10—Cleaning Up. After allowing the glue to harden for at least five hours, carefully remove any excess glue that may still remain. Then sandpaper with No. 0 sandpaper, slightly rounding all sharp edges. The piece will then be ready for the finishing operation.

Step No. 11—Finishing. Apply one coat of thin white shellac to all parts. When this is hard and dry, sandpaper thoroughly with No. 0 sandpaper. Now apply the desired color of lacquer, using a sprayer if available.

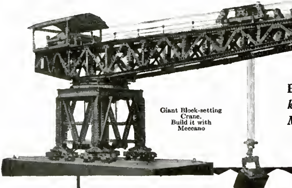
This article is the fifth of a series in which Mr. Klenke, through the courtesy of various manufacturers, is demonstrating the use of many new home workshop machines of both combination and individual types.



Assembly drawing of the shelves with the curved outlines which are to be enlarged by laying them out on 2-in. squares

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Boys! here's a Million Dollars worth of Fun!



Giant Block-setting Crane. Build it with Meccano

EVERY BOY *likes to see, and know why the wheels go round, Meccano answers every question.*

Self-operating Jib Crane Build it with Meccano

IT'S dead easy making models with Meccano. There are more than 200 accurately machined parts—a part for every purpose—of sturdy steel strips, with holes every half-inch apart; Brass Pulleys, Gears, Girders, Axle Rods, Couplings, Nuts and Bolts, Miniature *Dunlop Rubber Tires* and a host of other parts forming a perfectly interchangeable mechanical system.

There is simply no end of fun with it, building models from the simplest to the most advanced, including every mechanical invention known to the engineering world. They all work like the real thing. What's more, these models actually operate when hooked up with the powerful *Meccano electric motor,* which comes with outfits No. 5 and Nos. 20 to 70.

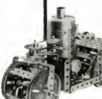
If you want to become a famous Engineer, commence now. All models illustrated in our manuals are built on correct engineering principles.

FREE—The big Meccano booklet for boy engineers tells all about Meccano in words and pictures. You can have your copy *free,* merely by sending the names and addresses of three of your pals. Write them on a post card, with your name and address. Meccano Company, Inc., Dept. A-1, Elizabeth, N. J.

MECCANO OUTFITS

No. 0	Makers	472	Models	$1.50
No.10	"	727	"	3.50
No. 5	"	496	"	5.00
No.20	"	737	"	7.50
No.30	"	785	"	10.00
No.40	"	836	"	15.00
No.50	"	893	"	25.00
No.60	"	936	"	35.00
No.70	"	983	"	55.00

Trans-Atlantic Monoplane Build it with Meccano

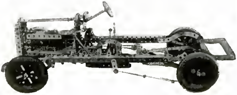


Steam Roller Build it with Meccano

MECCANO

TOY ENGINEERING FOR BOYS

Real miniature Dunlop Tires. For Meccano automobiles. With Outfits No. 5 and Nos. 20 to 70



Realistic Automobile Chassis Build it with Meccano

THE latest development of applied SCIENCE!

New Gun Shoots Targets and Small Game without Powder

The New

CROSMAN REPEATER

Deadly Accuracy and Tremendous Power

THE new Crosman Silent .22 embodies the most advanced principles of the use of air as power. It has all the advantages of any first class .22 rifle and these exclusive features:

1. **Absolutely noiseless.**
2. **Never needs cleaning.**
3. **Low cost ammunition.**
4. **Amazing accuracy.**
5. **No bullet splatter.**
6. **Adjustable power.**

The Pride of Hundreds of Target Shooters

Its marvelous accuracy and perfect balance, its beautiful finish and many outstanding features make the new Crosman Repeater the pride of target shooters everywhere and one of the most popular guns for all round sport. For the first time, men living in the cities and the suburbs can now enjoy the pleasures of target shooting—in the cellar or back yard.

Small Game HUNTERS

You can knock 'em dead in their tracks with this new, high-powered, silent rifle. After you have used the new Crosman Repeater you will never want any other small bore rifle.

The Only Gun of its kind in the World

The new Crosman Repeater is the only high-powered repeating rifle in the world that is powered by air. It is built to give lifetime service and guaranteed for one year against defects in workmanship and materials.

Special for Christmas

Repeater or Single Shot rifle, packed in an attractive holiday container, makes the ideal Christmas gift.

Free Book

Written by a man who loves a gun. For men who love guns, this booklet "Target and Game Shooting" is full of interest. Send in the coupon below--today. Every man who likes to shoot should have a copy of this booklet.

CROSMAN ARMS CO.
465 St. Paul St.
Rochester, N.Y.

SEND IN THE COUPON TODAY

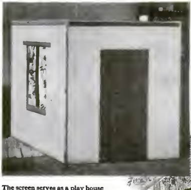
Please send your
FREE booklet described above.

Name..

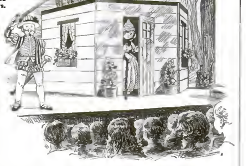
Address..

City.............................State..................

Play Screen *for* Children



The screen serves as a play house or as scenery for children's plays.



A PLAY screen that resembles a house and can be folded for storage when not in use makes an ideal addition to any child's Christmas toys.

As a school project, its construction is such that it makes an instructive shop problem; and since it is almost indispensable as part of the kindergarten equipment, the shop department can receive monetary credit for the work and materials that were used in construction.

The screen illustrated is the design of Jonathan Bright, an instructor at the Academy High School at Erie, Pa. It was awarded first prize in the intermediate woodworking division of a national shop problems competition conducted by the Educational Department of POPULAR SCIENCE MONTHLY.

To construct the screen, any available lumber may be used, but much labor and time can be saved by purchasing 1 by 2 in. white pine in random lengths from any convenient lumber or planing mill. If wall board is used to cover the framework, this can be ordered at the same time. Two sheets 4 by 10 ft. must be purchased, although only one and a half sheets are needed.

The first thing to do in constructing the three sections of the screen is to cut the wall board into four pieces, each 4 by 5 ft. Then pieces of wood are cut to length for the outside frame of each section, and are glued and nailed to the wall board. All of these pieces are placed even with the edge of the wall board except the bottom piece of the middle section, which is placed ⅛ in. from the edge. This is done to leave room for the band iron that is screwed in place later. The crosspieces forming the top of the door and windows, the pieces under the windows, and the vertical pieces at the sides of the doors and windows, are then fitted and glued and nailed in place in the order named. The three sections can be lightened considerably by covering the framework with burlap or unbleached muslin instead of wall board. However, if this is done, it will be necessary to strengthen the frame. The corners will have to be mitered, lapped, or mortised and tenoned, and the other joints also mortised and tenoned. The covering should be lapped over the edge and tacked on the edge or the back.

The frame for the door can be cut, glued, and nailed in place next. In sawing out the door, leave ⅛ in. on all sides for clearance when the door is fitted into place.

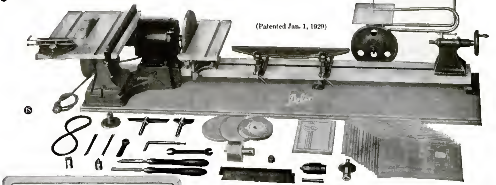
The braces shown in the corners are made from the short pieces of 1 by 2 in. stock left after the framework is made. They are cut in a miter box to about 6 in. long and are glued and nailed in place. The sections are allowed to stand overnight to give the glue a chance to set before cutting in the door and windows.

A series of ½-in. holes are drilled in the two corners diagonally opposite each other in the two window openings and a keyhole saw used to start the cut, sawing close to the frame. After the cut is started it is easy to complete the sawing with a crosscut handsaw. The same method applies to the cut across the doorway. In sawing out the door, be sure to saw close to the pieces forming the doorway, leaving any surplus wall board on the door.

The center section has a piece of ⅛ by ¾ in. by 4 ft. band iron screwed to the bottom edge across the doorway to hold the two sides of the section rigid.

The door is hung with a pair of ornamental brass-plated hinges, although any available hinges or butts may be used. Two stops are glued and screwed to the inside on one side of the door frame to

Announcing— The New "1930" Models "Delta" Woodworking Units



(Patented Jan. 1, 1929)

"*Delta*" Electric Handi-Shop

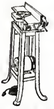
A complete Motorized Workshop for craftsmen, including all necessary equipment for Circular Sawing, Wood Turning, Scroll Sawing, Sanding, Drilling, Grinding and Buffing.

Practical Design — Dependable Quality — *Plus* Many Exclusive Features —

that's what you find in every woodworking unit bearing the Delta trademark. Craftsmen, artisans, farmers, mechanics—all who use wood in their daily labors or spare-time hobbies—are delighted with the sturdy construction, splendid efficiency, and moderate cost of Delta equipment. They appreciate keenly such exclusive constructional features as the Patented Tilting Tables, Automatically-oiled Bronze Bearings, Heavy U-Shaped Lathe Bed, Circular Saw Raising Lever in the Handi-Shop—the new Welded Steel Stands, Graduated Fence, Practical Rip Gauge, Graduated Miter Gauge, and the convenient arrangement, in the new Delta Jointer and Circular Saw Units, which can be used with your motor, if desired.

Combination 4-inch Jointer and 8-inch Circular Saw Unit

mounted conveniently on welded steel stand. Both machines can be used together or separately. Furnished with or without motor.



4-inch Jointer Unit

of new, practical design. Mounted on stand. Furnished with or without motor.

8-inch Circular Saw Unit

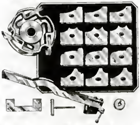
mounted separately on sturdy, welded steel stand. Furnished with or without motor.

10 Day Trial
Easy Terms

For complete details and full description of the new 1930 Delta line, send coupon for FREE illustrated literature. Shows many items of interest to those who work with wood. You will learn, also, how you can try any Delta equipment for 10 days under actual working conditions at our risk. Choice of three convenient payment plans. Mail coupon TODAY!

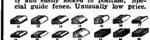
DELTA SPECIALTY CO.
Division of
DELTA MANUFACTURING CO.
1661-67 Holton St. Milwaukee, Wis.
DEPT. B-129

New "*Delta*" MOULDING CUTTER



Cuts Over 50 Moulding Shapes With Only 4 Sets of Blades

High speed blades produce over 10,000 cuts per minute at 3500 R.P.M. Blades require no individual adjustment. Quickly and easily locked in position. Special guide fence. Unusually low price.



DELTA SPECIALTY COMPANY, Dept. B-129
Division of "Delta Manufacturing Co."
1661-67 Holton St., Milwaukee, Wis.

Please send me FREE, Illustrated literature describing 1930 model "Delta" Woodworking Units. Also details of 10 Day Trial Offer and Easy Payment Plans.

Name..

Address..

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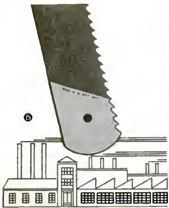


has "RED STREAK" hit YOUR plant?

Let "Red Streak" Hack Saws prove they out-perform any blade you've ever used.

WHEN you have a metal cutting job, you want it done as quickly and as easily as possible . . . you want the easiest and fastest cutting hack saw on the market.

You want "Red Streak" Hack Saw Blades! Mechanics in all types of trades praise the improved cutting qualities in "Red Streak" Blades. Electric furnace steel makes "Red Streaks" wear-resisting. Evenly set teeth make the cut go straight. They're made for those who handle a hack saw roughly.

Test the "Red Streak" in your hack saw frame and you'll be a booster, too. Look for the blade with the red end.

SIMONDS
SAW AND STEEL COMPANY
FITCHBURG, MASS.

RED STREAKS *"The Saw Makers"*
Established 1832 cut like lightning

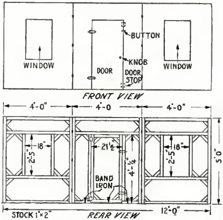
Branch Offices and Service Shops in Principal Cities

prevent the door from swinging in too far. A small wood button is screwed to the outside of the frame to keep the door closed when the screen is folded for storage. A small knob is also added to the outside of the door.

The three sections are hinged together with double-acting screen hinges to allow for the proper opening and folding of the screen.

The effects possible through decoration are unlimited. The screen can be painted to harmonize with any desired color scheme. The door frame and the window frames can be painted in a darker color to give a realistic effect. Another possibility is to paint bricks, shingles, or weather boarding on the walls. Small flower boxes for the outside of the windows and cretonne curtains on the inside of the windows give a pleasing effect.

The colors of the paint, cretonne, and other decorations are necessarily left to the individual taste of the builder of the screen. With a little thought and planning a realistic and attractive effect can be obtained.



Assembly of the play screen showing front plan of door and windows and scenerylike construction of the back members.

Embossed Leather Billfold

THE attractively embossed billfold illustrated could well be included in any list of Christmas gifts. It accommodates both the new and the old size bills and can be made by the easy and effective method of embossing previously described (P. S. M., Nov. '29, p. 102).

The 4 by 8 in. piece of leather for the front or outside of the billfold should be tooling calf, which can be bought at any large leather store. If tooling calf is not available, any of the better grade leathers to be found in the ordinary shoemaker's shop will serve the purpose.

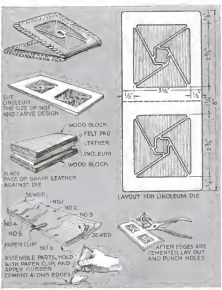
In addition to the leather for the front piece, one piece of thinner stock, 8 by 9 in., will be needed. This may be of any leather of ordinary thickness, lining calf or kid being the best suited. The color of this piece should match fairly well the outside of the fold.

Patterns are cut from paper to the shape and size of each piece, as shown in the drawing at the left. Leather then can be cut to the patterns and fitted to be sure that they are correct in size. Piece No. 1 should be large enough to take care of shrinkage when the leather is wetted for the embossing process.

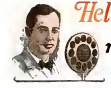
Several of the edges, as shown in the sketch, should be skived or thinned with a knife as indicated in the cross section on page 102.

The seams that hold the inside pieces in place can be sewed on a sewing machine.

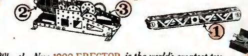
The embossed design may be as simple or as complex as you wish. The design shown is of the modern type and is very simple, and it can be made still simpler by omitting the diagonals. A piece of battleship lino-


CUT LINOLEUM THE SIZE OF NO1 AND CARVE DESIGN
WOOD BLOCK
FELT PAD
LEATHER
LINOLEUM
WOOD BLOCK
PLACE FACE OF DAMP LEATHER AGAINST DIE
5/8"
2¾"
3½"
½"
½"
1¼"
8"
2¾"
5/8"
LAYOUT FOR LINOLEUM DIE
SEWED
NO.1
NO 2
NO 3
NO 4
NO 5
NO 6
SEWED
PAPER CLIP
ASSEMBLE PARTS, HOLD WITH PAPER CLIP, AND APPLY RUBBER CEMENT ALONG EDGES
AFTER EDGES ARE CEMENTED, LAY OUT AND PUNCH HOLES

The design of the linoleum die; the arrangement of the die, pads, and blocks; the finished fold and the method of assembling it.



Hello boys! now you can build this Giant Air Liner with ERECTOR



HELLO BOYS! The boy who gets my new TRAIL BLAZING No. 8 ERECTOR for Christmas will sure be the talk of the town. When you've built your 5-foot model of a real trans-atlantic Zeppelin, your pals will flock from miles around to look it over—with its giant silver bag, gondolas, propellers, landing mast. And that's not all. I have worked all year to put into these new 1929 Erectors the thrills of a lifetime. You can build almost every mechanical invention you can imagine.

Think what a thrill you'll get building these wonderful models that whiz and hum along when operated with your big powerful Erector electric motor. Everything necessary lies beneath the cover of the brass bound chest that holds the new 1929 Erector. With its many new exclusive and patented parts, you can build one after another, over one thousand working models, including Airplanes, Automobiles, Trains, Steam Shovels, Locomotives, Derricks, Bridges, Power Plants; models of every description and kind.

Now, boys, here's the way to get this barrelful of red blooded fun. Send for the amazing Mysterious Erectorscope and Catalogue that tell all about Erector. Show it to your Dad—then take him to any good toy store. Let him see Erector himself—watch him warm up to it. He will want to build things with it himself. It's a sure way to get the World's Greatest Toy for Christmas.

A.C. Gilbert

SUNDAY AFTERNOONS

Tune in on

RADIO'S ZIPPIEST FEATURE

A. C. Gilbert's *Famous Sports Talks*

Let me introduce to you *Babe Ruth*, *Tad Jones*, and other great Sports Heroes of 1929! Hear them broadcast their inspiring messages to the boys of America. Every Sunday afternoon beginning November 10th. Remember the Time—5:30, Eastern Time—4:30, Central Time—3:30, Mountain Time—2:30, Pacific Time. Cut out the list of stations below and choose the one you get best on your radio receiver.

WEAF	New York
WEEI	Boston
WJAR	Providence
WTAG	Worcester
WCSH	Portland, Me.
WFI	Philadelphia
WCAE	Pittsburgh
WRC	Washington, D. C.
WGY	Schenectady
WCR	Buffalo
WSAI	Cincinnati
KYW	Chicago
WWJ	Detroit
KSD	St. Louis
WCCO	Minneapolis & St. Paul
WOC	Davenport
WHO	Des Moines
WOW	Omaha
WDAF	Kansas City
WTMJ	Milwaukee
WEBC	Superior, Wisconsin & Duluth
KOA	Denver
KSL	Salt Lake City
KGO	San Francisco
KOMO	Seattle
KFI	Los Angeles
KGW	Portland, Ore.
KHQ	Spokane

and other N. B. C. chain Radio Stations

The Trail Blazing No. 8 .... $25.00

The Set That Builds the Zeppelin. The giant ship of the skies, and hundreds of other great inventions. Includes girders for Zeppelin frame and landing mast, silver bag, gondolas propellers, stabilizers, and in addition includes all the parts of the Sensational No. 7½ Erector.

Sensational No. 7½ Motorized Erector Builds the Chassis $15.00

Here's the set I know will give you the greatest thrill you ever had. Fun? Oh, Boy! It's the real thing and there's a thrill packed in every one of its unrivaled parts. Boys, this is one great outfit, and there are hours of real sport waiting for you building automotive models. From this great assortment of distinctive, unsurpassable, patented feature ERECTOR parts you can build over 800 models. Automobile Chassis, Tractors, Scooters, Fire Engines, and a Hook and Ladder are only a very few. Packed in a big, red, brass-bound chest, has big 15-inch steel truck body, famous steel model building tray, 88-page, manual, powerful electric motor, completely assembled gear box, big red steel disc wheels with oversize balloon tires, fenders, radiator, hood, bumper, springs, steering wheel, heavy truck axles, cab top, steam boiler, steam shovel—in fact, 25 lbs. of scientific thrills for every day of the year.

Why the New 1929 ERECTOR *is the world's greatest toy*

1 Patented Erector Girder. A real genuine girder like engineers use. The interlocking edge, a novel, exclusive ERECTOR feature, eliminates bending and makes it possible to connect two girders, sturdy and strong, with a single bolt and nut, and a four piece square girder with two screws only. (In all Erector Sets.)

2 Patented Erector Motors. Powerful Battery Motor in No. 4, 6, 7, 7½ and 8. Famous Polar Cub 110-volt Universal Motor in No. 9 and 10.

3 Patented Assembled Gear Box. Adaptable to every possible gear combination, and for reversing movements. Convertible into 3-drum hoisting engine. Standardised for use with either battery or 110-volt Motor. Included assembled in the Famous No. 4 Set and up.

4 Heavy Steel Truck Body, 15 inches long. Exclusive ERECTOR feature. In No. 7½ Set and up.

5 3¾-Inch Solid Steel Disc Wheels with Balloon Tires. An exclusive ERECTOR feature. In No. 7½ and up.

6 Patented Big Giant Channel Girders, straight and curved. Electrically baked in brilliant red. Exclusive ERECTOR feature. In No. 7 and up.

7 Large Steel Model Building Tray, pierced with ERECTOR standard holes. Patent pending. Exclusive ERECTOR feature. In No. 6 and up.

New Erector Zeppelin Features

Patented Erector Zeppelin girder, silver bag, gondolas, propellers, stabilizers, rudders, etc.

Other Exclusive Sensational Features

Patented curved girders (in all sets); giant fly wheel machine frame (making possible the building of machinery models); Patented duplex base plate (double standard holes, making it possible to use axles of two sizes); Erector Dredge Bucket, Tip Bucket.

Exclusive Mechanical Wonder Features

Duplex Plate, Cam, Flat and Cone Pulleys, Quarter and Internal Gears, Eccentric Loop, etc.

Exclusive Erector Airplane Features

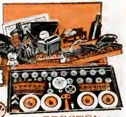
Fusilage, wings, cylinders, propellers, stabilizers, rudder, pontoons, struts, nose, swivel.

Sensational Automotive Features

Truck body, fenders, radiator, hood, axles, steering wheel and knuckle, springs, bumper, heavy duty disc wheels, etc.

A Few of the many other Countless Features

Steam Boiler, Steam Shovel, Boiler Plate, Bull Ring, Segment Plate, Perforated Strips—four holes to the inch (in all sets); Erector Gears—Pinion, Crown, Flat, Mitre, Helical, Internal, Quarter, Worm. The only construction toy for duplicating every engineering feat. Possible with no other toy but the NEW ERECTOR. Made from structural steel, plated, brilliantly enameled in colors and electrically baked. Perfectly interchangeable owing to the minute details of standardisation. Contains an unrivaled assortment of parts and builds more models than any other construction toy.



Famous ERECTOR *Sets*

The New Big No. 7....... $10.00
The Set that Builds the Steam Shovel.

The Wonderful No. 6.......$7.50
In the Big Red Chest with the Steam Boiler.

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With Powerful Electric Motor and Gear Box.

Dandy Beginner's Set No. 1..$1.00
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The Set with the Long Girders.

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The Mechanical Wonder Set, with 110-volt Motor.

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Complete, Unsurpassable, ERECTOR in all its glory.

Erector Electrical Set, No. 3005.................................$5.00
The Set that Electrifies and Illuminates.

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Flies by an Electric Motor.

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BIG BOY TOOL CHESTS
GILBERT CHEMISTRY
AND MYSTO-MAGIC

FREE! *As long as they last* A. C. GILBERT'S

AMAZING AND MYSTERIOUS ERECTORSCOPE

The first lucky 100,000 boys will get absolutely free the Mysterious Erectorscope. It will fool the smartest boy. You have never seen anything like it. Just look through the Erectorscope; you will not believe your eyes. Everybody will want to look through it. Mail the coupon today and get your Erectorscope and Gilbert Toy Catalog

THE A. C. GILBERT CO.
124 Erector Square, New Haven, Conn.

Please send me my free copy of the Mysterious Erectorscope and Gilbert Toy Catalog.

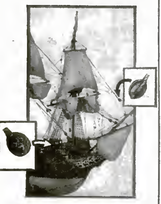
Name..

Street..

City..

State..

For Model Boats



PLASTIC WOOD
[Reg. U. S. Pat. Off.]

For Making Blocks

Blocks and Deadeyes can be readily moulded with the fingers, right into the stays if desired, and the holes punched with ease before the Plastic Wood hardens, without danger of chipping or splitting.

Sealing Bulwarks

Use Plastic Wood to build up, inside or outside, when the bulwarks do not quite fill the rabbet.

Mast-Head Caps

are easily made and securely fastened with Plastic Wood. Sand them smooth after hardening.

Figureheads

Much ingenuity can be shown by shaping Plastic Wood to intricate figureheads. After hardening it can be further worked with tools without chipping or splitting.

If Plastic Wood hardens too rapidly while working, or for thinning it, or cleaning hands and tools, use Plastic Wood Solvent. In 25 and 50-cent cans.

Handles like Putty

1 lb. can $1.00

Hardens into Wood

¼ lb. can 35 cts.

At Hardware and Paint Stores

ADDISON-LESLIE COMPANY
322 Bolivar Street Canton, Mass.

leum, exactly the size of the billfold, is used for the die. The design is laid out on the face and carved in very low relief. If the carving is done with a penknife, the background should be gouged out in chunks, leaving the carving rough and pebbly. Some wet paper impressions should be made first to make sure that the result is just what is desired. The leather is then thoroughly wetted and pressed into the die by using a vise or press, as shown.

When the embossed section has dried thoroughly, and the various edges have been skived, sewed, and fitted where necessary, the parts are cemented in place with ordinary rubber cement. Care should be taken to be sure that the cement is placed only on the edges.

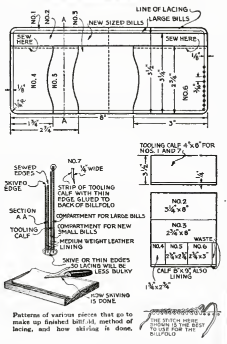
The billfold is now ready to be laced. The holes for the lace are punched with an ordinary nail set or a leather punch through all of the thicknesses of leather at once.

The lacing is usually kangaroo or wallaby skin cut as shown, but any thin leather will serve the purpose; even the leather salvaged from an old pair of shoes or slippers may be used. The correct width of the lace is about 3/32 in., and should be cut to a length of about six times the combined distance around the billfold. To flatten out the lacing, the laced fold should be hammered along the edges, and then shellacked to make it stiff.

If a colored effect is desired, the color may be applied over the pebbled surface, wiping lightly until the desired tone is obtained. Any oil or flat artists' color may be used, if thinned down with gasoline or benzene.

The whole billfold when completed is carefully waxed with a good grade of ordinary floor wax or shoe polish in order to provide a smooth, finished-looking surface.—F. Clarke Hughes.

This is the second of a series of articles by Mr. Hughes dealing with applications of this new, easy, and efficient method of embossing leather.



NO.1
NO.2
A
NO.3
NEW SIZED BILLS
LINE OF LACING
LARGE BILLS
SEW HERE
SEW HERE
1/8"
NO. 4
NO. 5
3½"
3¼"
2¾"
NO.6
3/16"
1/8"
1/8"R.
1¾"
A
8"
2¾"
3"
TOOLING CALF 4"x8" FOR NOS. 1 AND 7
3½"
¼"
NO.7
¼" WIDE
SEWED EDGES
SKIVED EDGE
STRIP OF TOOLING CALF WITH THIN EDGE GLUED TO BACK OF BILLFOLD
SECTION A A
COMPARTMENT FOR LARGE BILLS
TOOLING CALF
COMPARTMENT FOR NEW SMALL BILLS
MEDIUM WEIGHT LEATHER LINING
NO.2 3¼"x8"
NO.3 2¾"x8"
WASTE
NO.4
NO.5 2¾"x2¾"
NO.6 2¾"x3"
CALF 8"x9", ALSO LINING
1¾"x2¾"
SKIVE OR THIN EDGES SO LACING WILL BE LESS BULKY
HOW SKIVING IS DONE
THE STITCH HERE SHOWN IS THE BEST TO USE FOR THE BILLFOLD

Patterns of various pieces that go to make up finished billfold, method of lacing, and how skiving is done.

Sharp Knife Aids in Model Plane Building

THE most important tool in model airplane building is a sharp knife. Some model builders prefer using a safety razor blade, feeling that it is sharper and therefore more efficient and quick cutting. This is very true, but it also presents the ever-present danger of a badly cut finger. A knife is much to be preferred, and if sharpened frequently in the manner to be described, it will perform every cutting job quickly and accurately.

In sharpening a knife, hold the stone in the palm of your hand, put a few drops of oil on it, and place the knife blade, cutting edge flat, on the surface. With a gentle rotary motion, rub the blade on the stone. When the blade is free from nicks, it should be whetted on the smooth side of the stone until it begins to stick as you rotate it. The blade is now ready for stropping.

Place the blade flat on a leather strop, the cutting edge toward you. Stroke the blade away from you and at the end of the stroke give the blade a half turn and draw it back toward you. Just turn the wrist until the edge of the blade points opposite to the direction of stropping.

Three or four minutes of rapid stropping will be ample. Try the blade by seeing if it will slice paper without tearing it. —A. W. Jackson.

Toy Plane with Controls

EVER handle a joy stick? Well, if you happen to be a boy—particularly a boy whose father likes to help you build things—you will be able to do it next month. An article will be published in the January, 1930, issue of POPULAR SCIENCE MONTHLY telling how to construct a good-sized toy airplane cockpit where you can sit and work controls just as in a real plane. And a model mounted in front will bank and turn in response to every movement of your joy stick and rudder bar.

NATION-WIDE CONTEST TO ENCOURAGE APPRECIATION AND PERFORMANCE OF MUSIC BY THE YOUTH OF AMERICA

Eminent musicians and educators, civic authorities and leaders of public opinion have been so eulogistic in their praise of the harmonica as a means of fostering in the youth of America a proper appreciation of things musical, that a nation-wide contest has been inaugurated to intensify the already keen interest of American youth in this universal musical instrument.

BOYS and GIRLS
$1000 in PRIZES

HERE is *your* opportunity to win a valuable prize and to have plenty of fun while doing it. This is a contest for every boy and girl—and there are more than five hundred fine prizes to be awarded. Regardless of how old you are, or in what grade at school you are, you all have an equal chance to win one of the prizes. The judges will take all this into consideration when making their decision.

Simply use the coupon in the corner below to ask for a Hohner Instruction Book so you can quickly learn to play a tune on the harmonica. The Hohner Instruction Book will give you a head start on the boys and girls who neglect to get one.

Along with the instruction book, you will receive an entry blank and a harmonica catalog illustrating almost fifty models of the famous Hohner harmonicas. The entry blank will tell you just what to do, and how to proceed in competing for the more than five hundred prizes which will be given away.

Hohner "MARINE BANO" the ideal instrument for the beginner, embodying almost two octaves in the diatonic scale. . . . . Price 50c

Hohner "AUTO VALVE". Ten double holes. Wind-saving device permits greater volume of tone with no more effort . . Price $1.00

Hohner "CHROMONICA" Supplies all half-tones by the slight shifting of a lever. Any selection, in any key, can be played on it Price $2.75

How to Enter the Contest

The contest is for the best compositions on the subject: "My Experience with the Harmonica."

It is easy to enter this contest. Every boy and girl under eighteen years is eligible. You don't even have to buy a harmonica to enter this contest. You don't even have to own a harmonica. Even if you have never tried to play a harmonica in all your life, you can compete for a prize.

Remember, whether you enter the contest or not, the Hohner Instruction Book will be a big help to you. Even if you don't succeed in winning a prize, the ability to play a real musical instrument will be its own reward. Playing a harmonica will add so much to your personality and popularity, to your happiness and cultural development, that you'll always be glad you learned to play one.

FREE
TO EVERY ENTRANT

If you desire to purchase any of the models shown above, and cannot obtain them from your dealer, we shall be glad to fill your order by mail, postage paid, on receipt of money order for the price.

HOHNER
Harmonicas

Contest Editor, Dept. 504-M,
M. HOHNER, Inc., 114 E. 16th Street
New York City, N. Y.

Please send me FREE items checked below:
Instruction Book ☐ Catalog ☐
Entry Blank ☐

Name____________________

Address____________________

City____________ State ____________

This Christmas Gift brings You Popularity

THOUSANDS will start toward musical success on Conns this Christmas. The one gift that brings you fun … popularity and endless chances to make extra money. Join a band or orchestra. It's easy. Anyone who can whistle a tune can learn quickly.

Easy to Play

Saxophone, Cornet, Clarinet, Trumpet, Trombone—any band or orchestra instrument you choose. Conn makes them all. And Conns are easiest of all to play. Choice of Sousa and the world's greatest artists. Especially recommended to beginners for quick progress. *Easiest* to blow, *Easiest* to finger. *Easiest* to play in perfect tune. The result of more than 50 years' experience and patented processes of manufacture exclusive with Conn—the *world's largest maker.* Yet a genuine Conn costs you no more than any so called standard make.

FREE TRIAL, Easy Payments

Any Conn instrument sent for free trial in your own home. Easy payments if you wish.

Write for FREE BOOK

Write now for interesting booklet illustrating latest models in colors: Tells everything you want to know about your favorite instrument. Mention instrument.

C. G. CONN, *Ltd.*, 1232 Conn Bldg. Elkhart, Indiana

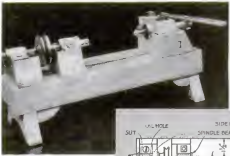
CONN
WORLD'S LARGEST MANUFACTURERS of
BAND INSTRUMENTS

C.G.Conn, *Ltd.*, 1232 Conn Bldg., Elkhart, Ind.
Gentlemen: Send free literature and details of trial offer on_______________(*Instrument*)
Name_______________
St. or R. F. D._______________
City_______________
State, County_______________

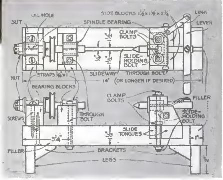
MAIL THIS COUPON

Toy Woodworking Machines

By
M. CYLE SMOCK, Jr.



Aside from being a toy reproduction of a lathe, this small machine can be used in making ship model deadeyes, capstans, and the like.



THE miniature motor-driven workshop machines shown, consisting of a lathe, drill press, sander-jointer, and circular saw, not only serve as educational toys for children having a mechanical turn of mind, but will actually turn out work that is accurate enough for model parts and small toys. The cost of building these machines is negligible; for instance, the lathe cost the writer a little over a dollar to complete.

For those who wish larger drawings and more complete details, a blueprint has been prepared to show the actual construction of each part as well as the assembly of all four machines. This blueprint can be obtained by sending twenty-five cents to Popular Science Monthly, 381 Fourth Avenue, New York, N. Y., with a request for Blueprint No. 113 (see page 110).

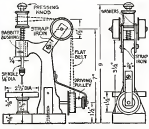
The lathe has an over-all length of 14 in., but the builder can increase it up to 24 in. successfully, if desired. The spindle is held in bronze bearings, which are split to facilitate tightening when they become loose. A model-T Ford front axle steering spindle body bolt was used for the spindle. As the bolt is ½ in. in diameter, it allows the use of standard chucks and faceplates such as are sold by many of the manufacturers of portable type woodworking machines.

In preparing the bolt, remove the bolthead just below the oil groove and smooth up the cut with a file. The straps that hold the spindle bushings in place can be made from 1/16-in. sheet brass or strap iron.

In a small lathe of this type there is very little thrust, therefore a small brass washer placed between the pulley and the end bearing block will serve the purpose of a thrust bearing.

In setting up the spindle, great care should be taken to see that the bearings are in line and that the spindle is allowed to turn easily.

The dead center is of the lever controlled variety (shown in the illustration at the top of this page). The lever is made from a ¼ by ⅝ by 8 in. strap-iron piece, and is held in place with 3/16-in. stove bolts, cut off at the right length and riveted over. The tailstock, which has a slide bolt for locking the stock at any position on the ways, is made from five pieces of wood: the two main pieces, the clamp for holding down the spindle bushing, and the two spacing blocks.



The miniature drill press. The chuck, taken from a hand drill of the spiral type, is pinned and soldered to the spindle.

Finish the wooden parts of the lathe with two coats of shellac and then enamel to suit.

The base and brackets of the drill press are cut from ¾-in. wood while the frame is made of ⅞-in. stock. The table, which is supported by a spool, is cut from ⅜-in. stock to a diameter of

HERE'S A LIONEL ELECTRIC RAILROAD THAT ANY BOY CAN BUILD

Lionel Electric Trains are priced from $7.00 to $325.00.

ON THE RADIO

Starting Nov. 8th

Every Friday night, 6:30 to 7 00 Eastern Standard Time, "Uncle Don" and his Lionel Engineers' Club over stations WOR, WLW and WBBM Listen-in and enjoy this wonderful Lionel radio program, and laugh with "Uncle Don."

FREE BOOK

FREE: *Don't delay another instant. Write today for a FREE copy of the new Lionel 46 page handsomely illustrated Railroad Planning Book and catalog, and pick out the set you want for Christmas*

THESE photographs tell the whole story better than a thousand words. They show you how *Lionel* Model Electric Trains look in action! They picture the realism of these remarkable locomotives and cars. They show you what you can do with your *Lionel* trains and accessories this Christmas.

With such a *Lionel* Electric Railroad you learn many of the details of actual railroading, for *Lionel* Railroad Systems are true-to-life models of the big railroads of the country.

See the new *Lionel* Steam Type Loco—electrically driven by the famous *Lionel* "Bild-A-Loco" motor—the motor that may be removed in a jiffy, taken apart and reassembled again.

Also, see the new *Lionel* electric type locos. These "Giants of the Rails" are the most powerful model electric locos ever built.

Remember, to, that *Lionel* trains can be controlled and operated by *Lionel* "Distant-Control"—which enables you to start, stop, reverse or switch your trains at any distance from the track.

Write for the catalog today—it shows all the new *Lionel* models. See the *Lionel* demonstrations at your local stores. The Lionel Corporation, Dept. D 15-17-19 East 26th Street, New York City

LIONEL

ELECTRIC TRAINS

MODEL RAILROAD ACCESSORIES ◆ "MULTIVOLT" TRANSFORMERS

THE LIONEL CORPORATION, Dept. D, 15-17-19 East 26th Street, New York City

Never before —such STRENGTH in a screw driver!

Prying open a cylinder head with the Bridgeport Red Crown—one of the many hard uses for which mechanics choose this powerful screw driver.

Guaranteed!

1. You can't *twist* the handle—the hexagonal head and heavy steel rivet prevent turning.
2. You can *hammer* the head — its broad steel surface takes the blows.
3. You can *pry* with it—its one-piece heat-treated blade *withstands* tremendous leverage.
4. You can *chisel* with it in an emergency—its dual tempered and twice-tested point won't mushroom.

RED CROWN

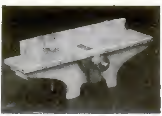
IF we could make the Bridgeport Red Crown one iota stronger, we would—but we *can't!* Skilled workmen tell us they have *never* seen a screw driver so powerfully built.

Look at the transparent view, above. Read about the remarkable *combination* of features—found in no other screw driver. Then you will know why *expert mechanics* prefer the Bridgeport Red Crown. And you will know why *you* should own this extraordinary tool!

Ask your dealer today to show you the Bridgeport Red Crown—identified by the bright *red crown* atop the handle. If he can't supply you, order direct—50¢.

THE BRIDGEPORT HARDWARE MFG. CORP.
Bridgeport, Connecticut, U. S. A.
The World's Largest Makers of Screw Drivers

Bridgeport TRADE MARK
THE CHOICE of MEN WHO KNOW TOOLS



2½ in. The two arms are made from ⅛-in. strap iron and are bolted to the top of the frame as shown.

Iron washers are put between the pulleys and arms to serve as bearings. On the inner sides of the spool pulleys is a disk of sheet tin, 1¾ in. in diameter, which serves to keep the belt from running off of the pulley. The shafts, on which the pulleys run free are made from 3/16-in. nails cut to the right length and slipped through holes in the arms.

The spindle is a ¼-in. rod 4½ in. long. Its bearing is made by first boring a ½-in. hole in the arm (spool) and afterwards greasing the spindle and centering it in the hole. Melt some babbitt in a ladle and pour it in around the spindle. In this way the bearing is formed right in place and around the spindle.

The chuck was taken from a small drill of the hand variety that can be bought in many five-and-ten-cent stores. It is soldered and pinned to the end of the spindle.

A coil spring is slipped on the chuck spindle, as shown, and serves to keep the chuck raised when no pressure is applied to the knob on the top of the spindle.

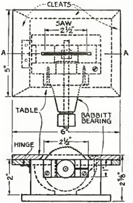
The circular saw uses a small, thin 2½-in. diameter metal saw, since woodworking saws are not ordinarily made in such a small size.

The bearing for the saw spindle is molded of Babbitt metal in a wooden mold cut to the size and shape desired. With a fine-tooth hack saw, slot the front half of the bearing; this will offer a means of taking up the bearing wear. The spindle is a ¼ by 4½ in. long steel rod, threaded for a distance of about ¾ in. on the inner end.

The saw is held in place by putting a right-handed nut on the spindle, then the saw and another right-handed nut. This will hold the saw firmly in place and will allow any adjustments that may be necessary.

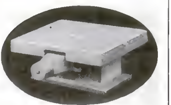
The table top is hinged to the frame with a 1 by 1½ in. hinge.

After the frame and top have been made, the bearing put in place, and the belt to the countershaft connected, raise the table and attach the saw blade. Start the motor and lower the table on the saw.



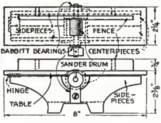
SIDE ELEVATION
(TABLE IN SECTION ON LINE A-A)

The babbitt bearing is cast in one piece in a wooden mold and is split.



As small circular wood saws are practically unobtainable, a 2½-in. diameter metal saw is used.

The drum sander is designed to simulate an actual jointer of the commercial motor-driven bench type.



In this way the blade will cut its own slot and thus will be assured of an accurate fit.

No ripping fence or miter guide is shown because a piece of wood clamped to the table top with C-clamps serves the purpose.

The drum sander is so constructed as to represent an actual bench jointer. The frame is cut from ¼-in. stock while the centerpieces are made from ⅝-in. Cut the slot in the table by sawing from the back at an angle of forty-five degrees. A mold for the bearing is made from wood, and the metal melted and poured. After the bearing is cold, saw the bar in half and drill for the spindle. Fasten the bearing in place with 3/16-in. countersunk machine screws.

The spindle is made from ¼-in. rod and is 3⅝ in. long.

The sander drum is 1 in. long and 1 1/16 in. in diameter and has a 1/16-in. hole for the pin which is made from a nail. The sandpaper is cut in convenient strips 1 in. wide and is glued on the drum.

The proper height for the sander drum to project above the table top can be found by a process of trial.

The belts can be made by using the leather obtained from a man's leather belt of the cheap variety. The only specification is that the leather be soft and flexible.

If any of the belts tend to slip, a few turns of tape on the pulleys will help to remedy the trouble.

The machines can be painted with a silver-bronze paint for the table tops and a gray enamel paint for the frames.

Ⓢ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

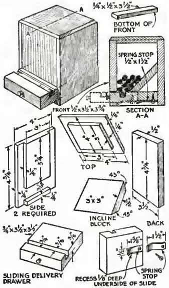
Semiautomatic Box Serves Cigarettes One by One

One of the cigarette boxes finished in green crackle lacquer over a black undercoat color.

The accompanying illustration shows an attractive cigarette box for the end table or smoking cabinet, which may be made easily in the home workshop. The only tools required are a saw, a plane, and a chisel.

For the school shop with such equipment as the dado saw and jointer—and when there is no objection to having the boys make smoking equipment for gift purposes or for sale—the making of a number of these boxes forms an instructive exercise in mass production.

It should be noted that the top of the box is glued in place. The cigarettes are inserted from the bottom. For that reason the spring stop is set in a recess so that it can be depressed sufficiently to allow the removal of the slide when it is necessary to refill the box. The boxes may be painted, finished natural, or lacquered. —H. R. Goppert and E. Sprague.



Principal parts of the case, a cross section, and a sketch as it appears when assembled.

To and Fro

{Turn right ⇄ then left}

drives the screw

ADD this pair of "Yankee" Ratchet Screwdrivers to your kit. Ingenious tools . . . efficient . . . interesting to use! You grasp handle just once and simply turn it to and fro.

Tiny screw started by turning blade with thumb and forefinger.

The "Yankee" Ratchet drives the screw. Saves your strength and time. Smooth as stem-wind on your watch. No friction—no turning screw back. One hand does the job. And not a moment or motion lost. Where many screws are driven, the "Yankee" Ratchet saves a fourth to half of man's time.

No. 15.—Takes care of pesky little screws. "Thumb-turn" on blade starts the wobbly screw. Ratchet movement drives it home. Blade, $\frac{3}{16}$" diameter. Six lengths: 2", 70c; 3", 75c; 4", 80c; 5", 85c; 6", 90c; 8", 95c.

No. 10.—For husky screws. Eight blade lengths: 2", 65c; 3", 80c; 4", 85c; 5", 95c; 6", $1.05; 8", $1.20; 10", $1.45; 12", $1.60. Ratchet Shifter moves lengthwise.

No. 11.—Same as No. 10, except Ratchet Shifter moves across tool. All have right and left ratchet and rigid adjustments.

It is a relief in many places to be able to ratchet the screw home with one hand.

"YANKEE" *"That's the best there is!"* says the man who sells tools.

"YANKEE" TOOL BOOK COUPON

North Bros. Mfg. Co., Philadelphia, U. S. A.

Send "Yankee" Tool Book, showing Quick-Return Spiral Screw-drivers, Automatic Push Drills, Ratchet Hand, Breast and Chain Drills, Automatic Bench Drills, Ratchet Braces, Bit Extensions, Push Braces, Ratchet Tap Wrenches, Removable-base Vises, etc.

Name ....

(PS) Address ....

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

A $100 SHIPMODEL for $4.98

SANTA MARIA
25" High; 11" Wide; 27" Long

You can put a beautiful Ship Model together in a few hours of pleasant pastime

Let the World's Largest Builders of Ship Models supply you with all the oecessary parts cut to fit and ready to put together for the models, Santa Maria, Mayflower, or La Pinta. You need not know anything about ship huilding to assemhle one of these models. If you have never seen a ship model you can put one of these models together in a few hours by following our diagram and instruction sheets which explain and show you exactly what to do with each part. All you oeed is a small tack hammer to tap the parts io place. The diagram makes it impossihle for you to go wrong. These models when completed are exact in every detail of the famous old ships they represent, and when completed will add a distioctive touch to your home. We also have parts for the models for the Constitution aod Flying Cloud at $6.98; all other models listed at $4.98 each.

Mayflower; Size: 26" high, 10" wide, 30" long $4.98
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Four Useful Everyday Knots

By

Walter E. Burton

ONE of the most useful members of the koot family is the square or reef knot. It is employed for tying two rope ends together aod is perhaps the most satisfactory device for securiog the cord on packages. Its many other uses include the tying of baodages, for it can he adjusted to just the right degree of tightness.

The square knot (Fig. 1) is essentially the loopiog of two rope ends about each other. First twist the ends together once, bring them up bending tbe rope so that they point in directions opposite their first position, and loop one ahout the otber again. Tben draw the knot tight. The only precaution is to see that the end of each section of rope is on the same side of the loop formed by tbe other piece as the main, or "standing," part. If it is not, the result will he the weaker "granny" knot. In tying the square koot, especially in binding packages, it may be

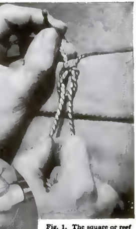


Fig. 1. The square or reef knot is easily tied, untied, and will never slip or jam.

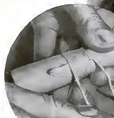


Fig. 2. This invisible-end wrapping is effectively used in mending split chisel handles and the like.

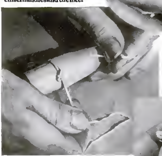


Fig. 3. Pulling the end through, thus fastening it and making it invisihle.

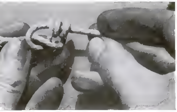
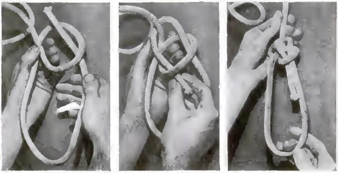


Fig. 4. The knot at the right, if tied on the end of a rope, prevents fraying and serves to keep the rope from slipping through a pulley or hole.



Figs. 5, 6, 7. The bowline when tied properly forms a loop that will never slip and is easily untied, and because of this is a useful knot for many purposes about the home as well as on board a ship. A piece of rope with a bowline at each end can be used for hanging a coil of garden hose on a hook.

necessary to hold the cord in place with the finger after the first twisting, until the knot is completed. The knot never slips or jams and is easy to untie.

A method of repairing split chisel or knife handles, tennis racket frames, and similar objects, and of forming a non-slipping grip on various handles, is to wrap them with a layer of cord. In doing this, the cord ends can be made invisible and secure by a simple little trick. When starting the winding, arrange the end of the cord so that a loop extends under the winding and a short distance beyond the area that will be covered. Wind the cord over the loop, as shown in Fig. 2. When the required amount has been applied, cut the cord so that a few inches remain, and pass the cut end through the loop. Then pull the starting end until the knot—if it can be called a knot—is beneath the winding (Fig. 3). Trim off the surplus cord.

Frequently it is necessary to form a knot at the end of a rope to prevent fraying or slipping through a pulley or hole. The method of doing this, which is shown in Fig. 4, consists simply of winding the end about the standing part several times, inserting it through the loop formed, and pulling it taut.

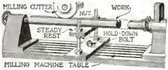
The bowline is a knot that appears complicated but really is easy to tie. Its purpose is to form a noose that neither jams nor slips. It is used sometimes for lowering a person by a rope, as from a burning building. A piece of rope a yard or so long, with a bowline noose at each end, makes an ideal device for hanging the garden hose from a nail or other projection, by first coiling the hose, passing the rope once or twice about it, and slipping the end loops over the support. A rope with a bowline loop is useful in tying a boat to a post.

Steps in tying the knot are shown in Figs. 5, 6, and 7. First form a small loop in the rope and bring the end around and up through this loop so that a larger one is formed. Pass the end about the main portion of the rope, bring it back down through the small loop in the opposite direction, and pull the knot tight.

Support for Slender Work

LONG shafts, which must be handled between centers for milling machine operations, frequently give trouble by springing down in the center. Sometimes blocks of various shapes are used; at other times there is a steady rest of some sort with the milling machine equipment.

In the event that there is nothing to support the shaft, a steady rest, one that is adaptable to a large range of work, can be made from two pieces of flat steel and two bolts. The construction and use of the device are evident from the illustration.—H. L. Wheeler.



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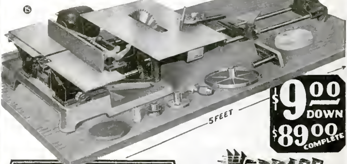

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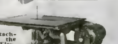

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Model of Darmstadt Type Sail Plane

By Vincent Johnstone

Model gliders act very much like real airplanes.

FROM building model sail planes much can be learned regarding plane construction and the principles of flight.

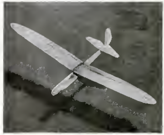
The glider illustrated, which is easily made, is a reproduction of the famous Darmstadt sail plane. Models of this type have flown on the level for sixty feet when launched from a height of a little over seven feet.

By variations in the way this sail plane is launched, it can be made to fly straight or loop both vertically and horizontally, simulating in many ways the actions of an actual airplane.

For making the wing you will need a 3/16 by 1½ by 18 in. piece of balsa wood veneer. Make a pattern of the wing and cut the balsa accordingly. The front edge of the wing, it will be noted, is the edge having the least curvature at the tips. Round both of the tips of the wood so that they are exactly alike.

Locate the center of the wing and with a sharp razor cut about halfway through the wing along the center line from front to back. Carefully crack the wing so that both wing tips will be ¾ in. higher than the center. Next cut a small piece of balsa 1¾ in. long by ⅛ in. deep at one end and ¼ in. at the other.

Place the wing upside down on a flat table or workbench, with the center of the wing supported by a block. With the wing in this position, carefully cement the 1¾-in. balsa strip across the center of the wing as shown in the sketch on page **112**. The small end of this balsa piece,



Balsa wood, wire, and cement are the only materials needed in making this model glider.

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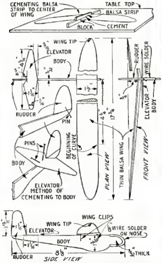
Tudor Morris, noted model plane builder, marking the wing position on his sail plane.

⅛ in. in height, should be even with the trailing edge of the wing, and the ¼-in. end should project out in front of the wing. It can be slightly rounded in imitation of the pilot's head to make the glider look more realistic, if you wish. Be sure that this crosspiece is set at exactly right angles to the entering and trailing edges of the wing, as this piece is used for mounting the wing in place. Also make sure that the strip is set directly over the break, as it helps to bind the two halves of the wing together.

Next, make two 11/16-in. spring wire wing clips as shown in the sketch on 113 and cement one at the front and one at the rear of the balsa crosspiece on the underside of the wings.

As a finishing touch on the wing, it might be well to check the balance and see that one wing tip is not considerably heavier than the other. If the wings are out of balance, sandpaper the heaviest wing tip until the wing does balance.

Make an actual size pattern of the body. Cut out the body from a 3/32 by 1 3/16 by 8⅛ in. piece of balsa veneer. The body should be sandpapered smooth



Dimensions of the model and methods of attaching rudder, balsa wing strip, and the elevator.

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and tapered in thickness only at the rear.

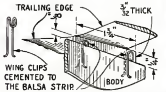
Next bend the 2⅜ in. long piece of ⅛-in. wire solder to fit the curvature of the nose of the body piece and cement it firmly in place.

The elevator is 4⅜ in. long and 1 1/16 in. wide and is shaped as shown in the drawing. The use of a pattern will simplify making it to the correct shape. The entering edge should be slightly rounded and the rear edge sandpapered to a thin knife edge.

The rudder, which has rounded edges, extends 1 13/16 in. above the top of the body, and is made from 1/16-in. balsa veneer.

Mount the rudder on the pointed end of the body so that it is straight up and down and neither turned to the right nor left. A small pin or needle will help to hold the rudder in place while the cement dries.

When the cement on the rudder is dry, the elevator can be cemented in place and held by two pins while the cement dries. The elevator should be mounted very carefully and in a true and correct position. It should be set at right angles to the body and rudder, and should be mounted without any spacing block underneath, so that its surface will be parallel to the top of the body.



UNDERNEATH VIEW OF WING ATTACHMENT

Method used in attaching the wings to the plane body by the means of spring wire clips.

After the cement is entirely dry, mark the front edge of the wing plainly so that you will always get it on in the proper way.

The wing has been made detachable for convenience and carrying and so that it will come off without damaging the model in case of a bad landing; furthermore, the adjustments can be made quickly and easily. After you have found the proper adjustment, however, you can cement the wing solidly in place if you wish; this should be done if the plane is to be used for stunting.

For a trial glide, slip the wing on to the body so that the entering edge of the wing is about 2 in. back from the nose. Then gently launch the model into the air with a slight forward push. Do not throw it. As it is launched, the model should be held on an even keel or with the nose slightly downward. It should be grasped about the center of balance, which is just under the wing. It is not advisable to hold the model by the tail in launching, because this will usually cause the nose to rise and the model to stall.

After several glides you will find that a slight adjustment of the wing, either forward or backward, may improve the glide. After you have found the correct position, carefully mark it with a pencil for future reference.

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A Few Facts about Applying Glue

THE operation of applying glue, contrary to the prevalent idea, is one of the utmost importance in the making of any jointed woodwork. The glue must not only be of the best quality, but it must be used in the right way.

What are the common kinds of glue?

Animal, casein, and liquid glue are the most common in home workshop practice. Hide glue is made from the hides, horns, and bones of animals. Casein glue is prepared from the curd of cow's milk. Liquid glue is made from fish stock as a rule, but sometimes from animal glue.

Test a joint carefully before applying glue.

What is the proper method of mixing animal or hide glue?

The amount of glue needed should be placed in the inside pot of a double boiler, and from 1½ to 3 parts of water to 1 part of glue, by weight, is added. The amount of water depends upon the grade of glue. The glue is then allowed to soak for twelve, eight, or three hours, according to whether it is cake, flake, or ground glue. After soaking the glue, fill the outside boiler with water and put the inside pot in place. Heat the glue until it becomes a jellied mass, being careful to see that the temperature does not exceed 140° F. at any time. Glue should be applied when it is at a temperature of 135°: this leaves 5° for cooling on the brush. It

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is well to heat the work also, if possible.

Hide glue must be fresh. For best results it should be applied not later than four hours after heating.

Can hide glue be saved and reheated?

Hide glue that has once become hard is weakened to such a degree that it is practically useless. The pot should be cleaned out thoroughly and a new batch made. Make only enough glue for your immediate need. Old glue left in a pot in which a new batch is being made reduces the value of the new glue 50 percent. A clean gluepot lessens the chance of poor gluing and weak joints.

How is casein glue mixed?

Casein glue may be prepared in any ordinary pot or receptacle. The powder is added *slowly* to the correct amount of water as designated on the package. Stir the mixture vigorously until it is about the consistency of heavy cream. Allow it to stand for about 15 minutes and then stir again. The mixture may seem quite thick after the first mixing, but it will thin out after it is allowed to stand as above stated. Mix only sufficient for the work in hand.

What are the advantages of casein glue?

Glue of the casein type requires no heating and forms a strong water-resistant bond. It is therefore excellent for outdoor as well as indoor work. Convenient to mix, it is equally easy to use as it sets slowly enough to allow ample time for adjusting and clamping joints.

What is the best method of applying liquid glue?

In applying liquid glue a stronger joint can be obtained by brushing on a thin sizing coat first and allowing that to dry before the final application. When liquid glue becomes too thick to spread easily, it can be thinned by the addition of water. In cold weather, however, it is usually sufficient to place the can in a dish of hot water.

Can liquid glue be used for any purposes other than mending and joining?

Gesso can be made by using liquid glue. A mixture of 1 gill of liquid glue, 1¼ cups of whiting, and 3 teaspoons each of linseed oil and varnish makes about one cup of fine quality gesso. Gesso is used as a decorative medium on picture frames and furniture.

What kind of a brush is best suited for applying glue?

A good bristle brush, preferably a regular glue brush. However, a basswood stick soaked in water for from two to three days and hammered so that the end fibers become separated makes a good substitute. As the end wears away, more of the fibers can be separated. If a brush gets hard, soaking it in water will restore it to its soft condition. Brush glue on quickly and vigorously and apply it to both parts to be joined. Next, clamp the work tightly so as to force the joint together and allow the glue to dry.

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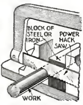
MANY machine hack saws are wasteful of saw blades, especially when large quantities of small-sized stock are cut. On stock up to 3 in. in diameter perhaps only one third of the length of an 18-in. blade is used. It thus happens that blades are sometimes discarded when they still have two thirds or more teeth that are practically unused.

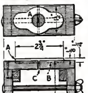


A spacing block to distribute the wear.

One shop employs a simple method for obtaining further service from the blades. When one section of the blade is dull, a short block of steel or iron is placed in the chuck to set the bars being cut farther ahead.—H. L. Wheeler.

Fixture for Holding Thin Work to be Ground

DIFFICULTY is often experienced in disk-grinding thin pieces like the flange shown at *A* in the accompanying illustration. The grinding of thin pieces is considered an unpleasant operation, as it brings the fingers close to the grinding wheel. However this trouble can be remedied in most cases by using a work-holding fixture.



How the wooden grinding fixture for thin parts is made.

The fixture shown for holding part *A* is simply a wooden frame with a recess cut at *B* about ⅛ in. deep and of the same shape as the flange to be ground. The upper member of the fixture is cut in two at *C*, thus forming two jaws which can be clamped on the work by tightening nut *D*.—Leonard Keiser, Jr.

Handle for Sheet Metal

THE difficult and often dangerous job of handling large sheets of metal may be made easy and safe by the holder illustrated. It is simply a loop of ⅝-in. steel rod just large enough to fit a man's hand, and with about 3 in. at one end turned back near the loop, leaving a space large enough to admit the metal. The turned-back portion is drawn down to a wedge shape at the end.—Joseph C. Coyle.

Top sheets are easily moved with this tool.

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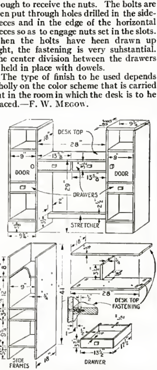
In its construction there are few points that require any further explanation than that given by the drawings. The horizontal portion of the desk is fastened to the upright supports by means of bolts. Slots are cut in the horizontal pieces large enough to receive the nuts. The bolts are then put through holes drilled in the sidepieces and in the edge of the horizontal pieces so as to engage nuts set in the slots. When the bolts have been drawn up tight, the fastening is very substantial. The center division between the drawers is held in place with dowels.

The type of finish to be used depends wholly on the color scheme that is carried out in the room in which the desk is to be placed.—F. W. Megow.



Assembly of the desk, and details of the drawer, end pieces, and fastening for top.

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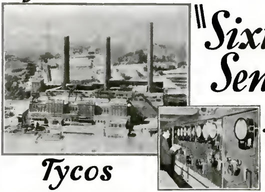

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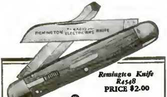

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Spotlights Brighten a Christmas Tree

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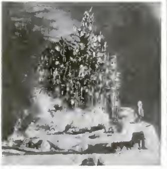


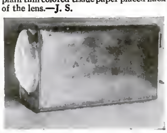
Many futuristic and artistic lighting effects can be obtained by using colored spotlights.

A tree lighted in this manner is shown, and with a little practice and a few trials many other artistic effects can be arranged.

Drill or punch a series of holes in the bottom of a regular square oil can, and cut a 4 in. diameter opening. Place this hole so that its center will be opposite the filament of a 250-watt stereopticon lamp, which is held in a suitable porcelain socket. Solder or bolt on the three clips that hold the short focal length lens in place. Both lenses and bulbs can be bought at photographic or motion picture supply houses.

Wire the socket, put a bolt through the screw hole, and fasten it to the can with a wing nut, so that it can be shifted readily. Carry the wire through the filling hole to a plug. As the spotlight will get hot, place it on two bricks for safety.

For colors, use colored glass, theatrical gelatin, or, if nothing else is available, plain thin colored tissue paper placed back of the lens.—J. S.



The spotlight is made from an ordinary oil can and a lens, and a 250-watt lamp is placed inside.

SCRATCHES in both enameled and varnished furniture can be temporarily concealed with ordinary wax crayons. Polish the retouched spots lightly with a soft cloth to bring out the wax luster.

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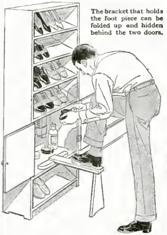
Advice for POPULAR SCIENCE MONTHLY readers regarding safe and profitable investments. See Page 4.

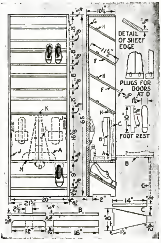


The bracket that holds the foot piece can be folded up and hidden behind the two doors.

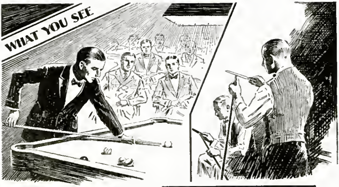
Compact Shoe and Polish Cabinet

IN MAKING the combination shoe case and polishing outfit shown, any easily worked wood may be used. It is made up of two ends ¾ by 10¼ in. by 5 ft. 5 in., one top ¾ by 10 by 20 in., one bottom the same size, and one plywood back ¼ by 20 in. by 5 ft. 5 in.; boards may be used for the latter if preferred. Assemble these pieces with sixpenny finishing nails, fastening the back in place with fourpenny common nails.

Make five shelves *F* ⅝ by 11½ by 20 in. and bevel their back edges as at *G*, and the front edges as shown by the detail. Cleats *H*, ½ by ¾ by 20 in., may be fastened with 1-in. brads at a distance from the back edge of each shelf *G* to suit the shoes to be kept thereon. Fasten these in place at about the angle indicated with sixpenny finishing nails, watching



Assembly of the complete shoe case and polishing outfit. Note position of foot-piece bracket.



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A Run of Fifteen

WHAT YOU SEE: A dark cone shedding a white light on a table covered in green . . . a leveled cue, the click of two ivory balls . . . a masterly shot completing a run of fifteen.

WHAT YOU DON'T SEE: **Before the match, the players roughing the tips of their cues — so that they will grip the balls better — with a Nicholson Flat Bastard File.**

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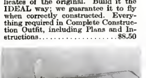

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carefully while the nails are being driven to be sure that they do not come out of the side of the shelf.

Cut out two ¾ by 10 by 16⅞ in. plywood doors. In fitting them, hang with 1¾-in. brass butts placed as at *J*, with a stop ½ by 2 by 6 in. glued and bradded as at *K*. Fit a brass spring friction catch at *D* to hold each door, with the striker on the inside of the bottom. A ¾-in. brass knob should be attached at *L*.

Fasten piece *B* into *A* with glue and 1-in. No. 9 screws. Make a foot rest and fasten to *B* as suggested. Hang piece *C* to *B* with a 3-in. iron strap hinge, place the assembled pieces on the bottom of the closet, and fasten with 2-in. hinges located as at *M* and back far enough to allow the doors to open and close freely.

The back and ends of the inside of the closet, together with the pieces *A*, *B*, *C* and the foot rest, should be painted black, for any other color will be defaced by spots of shoe blacking. The remainder of the case may be painted, lacquered or stained to suit.

Straps of cloth or leather or wood cleats may be fastened to the walls of the closet as indicated, to receive brushes, boxes, and bottles of shoe polish, and other accessories.—C. A. K.

Embellished Copper Letter Openers

After the blank has been cut, the operations are confined mostly to the hammer and anvil.

NOTHING in the line of decorative metal work is easier to make than a hammered copper letter opener. Aside from being work well within the limits of skill possessed by the average worker, the finished article is one that may well grace the finest mahogany desk or table.

As to form, several general shapes are illustrated, but there are hundreds of designs that can be used. There is one limitation, however: the handles should be 3½ in. long and the blades at least 5 in. long. These proportions will give the best results both as to attractiveness and balance.

After the design has been chosen, lay out a pattern of the knife on cardboard and then transfer the shape to No. 16

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For absolutely accurate boring, insist on the genuine Russell Jennings Auger Bits. Full name stamped on the round. Sold at all good hardware stores.

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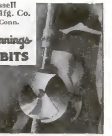

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P. P. Goerzen writes, "34-6/10 miles with the Whirlwind, or a gain of 21 miles to the gallon."

R. J. Tulp, "The Whirlwind increased the mileage on our Ford truck from 12 to 26 miles to a gallon and 25% in speed."

Car owners all over the world are saving money every day with the Whirlwind, besides having better operating motors. Think what this means on your own car. Figure up your savings—enough for a radio—a bank account—added pleasures. Why let the Oil Companies profit by your waste? Find out about this amazing little device that will pay for itself every few weeks.

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In just a few minutes the Whirlwind can be installed on any make of car, truck or tractor. It's actually less work than changing your oil or putting water in the battery. No drilling, tapping or changes of any kind necessary. It is guaranteed to work perfectly on any make of car, truck or tractor, large or small, new model or old model. The more you drive the more you will save.

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No matter what kind of a car you have—no matter how big a gas-eater it is—The Whirlwind will save you money. We absolutely guarantee that the Whirlwind will more than save its cost in gasoline alone within thirty days, or the trial will cost you nothing. We invite you to test it at our risk and expense. You are to be the sole judge.

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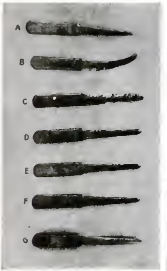


A copper blank; *B* one edge hammered; *C* both edges hammered; *D* edges removed; *E* filed edges; *F* blunt chisel finish; *G* bent handle.

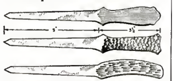
gage copper by drawing around the pattern with a pencil. With a pair of metal shears cut the copper to the line. The metal blank is now ready for the hammering operation.

The illustration *A* shows the blank as it is cut from the sheet copper, *B* the knife after the one edge has been hammered with a ball peen hammer. The other edge is now hammered until the bow in the blade disappears and it again becomes straight as in *C*. This brings the edges down to a knife-edge thickness.

With a pair of shears, cut the ragged edges from the blade. This can be done with considerable ease if one handle of the shears is placed in the vise, thus allowing more leverage. The knife after this operation is shown at *D*. With a file, clean up the edges until the blade has a good, smooth, straight cutting edge as at *E*.

The handle can be completed by using a blunt chisel as at *F*; this gives an attractive lined effect. Another method is to bend the handle as shown at *G*. There are as many actual variations for the handle design as there are for the letter opener as a whole.

Coloring the knives with a water solution of liver of sulphur gives a dark copper-colored tint to the knife and thus adds to its beauty. Finally, polish it with a clean cloth and apply any transparent metal lacquer.—DICK HUTCHINSON.



Dimensions of the knife and the plain, hammered, and blunt chisel designs for the handles.

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Building Furniture in Unused Doorways

By CHARLES A. KING

Combination ironing board and breakfast table built into an unused kitchen doorway. The table swings down when needed.

THAT unused doorway in your house, through which no member of the family ever passes, may be easily fitted with built-in furniture, which, if constructed separately, would occupy considerable space in the room.

The drawings below show how to build a desk, a linen closet, a service closet, or a combination breakfast table and ironing board. Some of the designs, as in Fig. 3, are adaptable to other pieces such as a buffet or a china closet.

The design in Fig. 1 can be used in building a desk and bookshelves, or merely the bookshelves. The combination desk and bookshelf takes the place of two bulky articles and extends only about 6 in. into the room. The case *A* is made about ¼ in. narrower and shorter than the doorway itself. The shelves may be either grooved or nailed into place. The desk lid may be supported most easily by using brass hinges as at *D* and chain desk-shelf supports as at *E*, but regular desk stays may be fitted if preferred. The top of case *A* and the desk shelves *B* and *C* are the full width of the case at these points, but the other shelves are set back about ⅛ in. so that the outer edges are not quite flush with the edges of the sides of the case.

Cloth or thin wall board can be used to cover the back of the case. After the completed piece is placed in the opening and fastened securely, a piece of molding *F*, ½ by 1¼ in., may be mitered around the case to hide the joints and attached with brads.

If the unused doorway is in the kitchen or the living room, it may be used to contain a breakfast table and ironing board as shown in Fig. 2. First fit and fasten the crosspieces as shown in section at *A*. The table top, which is made of ¾-in. plywood, is fitted to swing freely and hung from 3-in. brass hinges screwed to the closed door at the back of the case and to the table top, as at *B* and *C*. These hinges are so fastened that when the table top is lowered for use its underside will rest on the piece *A*, which serves as a support.

The ironing board should be hung with smaller hinges from the underside of the table top, so that it will not interfere with the dropping of the larger piece. When the table top is locked in a vertical position, the ironing board may be lowered for use. The upper part of the opening may be covered with a curtain on a roller, the lower with bright colored cloth. The table top is kept in a vertical position by a strong bolt fastener, and metal clips made as shown hold the ironing board.

AN OLD chest of drawers, which is easily obtainable, may be used in making the linen closet shown in Fig. 3. Shelves are built above to contain linens and are concealed by doors of ½-in. plywood. If a search of used furniture stores fails to reveal a suitable chest, the making of one will be an absorbing project for the ambitious homeworker. Trouble in sweeping can be avoided by filling in the space between the feet of the chest with a panel. Cross sections of the upper and lower parts are shown in the upper part of the drawing. Section *X* shows the construction of the lower cabinet, section *Y* the upper.

The service closet in Fig. 4 should be made deep enough, by building an extension out or in, to contain the vacuum cleaner. A diagram of this construction is shown in section *X*. Wall board forms the back of the closet, the original door the front. Brooms, mops, and dustpans may be held in place by the cleats *A* which may also serve as shelf supports. The wall board back is stiffened by cleats *B*, which support shelves placed as desired to hold dusting cloths, cans of polish, and cleansers.

IF MORE than moderate exertion is required to make a woodworking tool do its work, the tool is dull, improperly adjusted, or being incorrectly used.

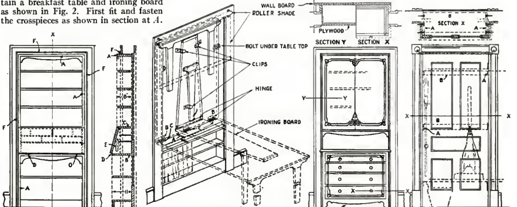

FIG. 1 DESK AND BOOKSHELVES

SECTION X

FIG 2 BREAKFAST TABLE AND IRONING BOARD

FIG 3 LINEN CLOSET IN BATHROOM

FIG 4 SERVICE CLOSET

Four suggestions for utilizing those superfluous doorways in old houses which are rarely or never used. Built-in furniture of this type has the great advantage of using no extra wall space.

"What? Learn Music by Mail?" *they laughed*

"Yes," I cried, *"and I'll bet money I can do it!"*

IT all started one day after lunch. The office crowd was in the recreation-room, smoking and talking, while I thumbed through a magazine.

"Why so quiet, Joe?" some one called to me.

"Just reading an ad," I replied, "all about a new way to learn music by mail. Says here any one can learn to play in a few months at home, without a teacher. Sounds easy, the way they tell about it."

"Ha, ha," laughed Fred Lawrence, "do you suppose they would say it was *hard?*"

"Perhaps not," I came back, a bit peeved, "but it sounds so reasonable I thought I'd write them for their booklet."

Well, maybe I didn't get a razzing then!

Finally Fred Lawrence sneered: "Why, it's absurd. The poor fellow *really* believes he can learn music by mail!"

To this day I don't know what made me come back at him. Perhaps it was because I *really was* ambitious to learn to play the piano. Anyhow, before I knew it I'd cried, "Yes, and I'll bet money I can do it." But the crowd only laughed harder than ever.

Suppose I Was Wrong—

As I walked upstairs to my desk I began to regret my haste. Suppose that music course wasn't what the ad said. Suppose it was too difficult for me. And how did I know I had even the least bit of talent to help me out. If I fell down, the boys in the office would have the laugh on me for life. But just as I was beginning to weaken, my lifelong ambition to play and my real love of music came to the rescue. And I decided to go through with the whole thing.

During the few months that followed, Fred Lawrence never missed a chance to give me a sly dig about my bet. And the boys always got a good laugh, too. But I never said a word. I was waiting patiently for a chance to get the *last* laugh *myself*.

My Chance Arrives

Things began coming my way during the office outing at Pine Grove. After lunch it rained, and we all sat around inside looking at each other. Suddenly some one spied a piano in the corner. "Who can play?" every one began asking. Naturally, Fred Lawrence saw a fine chance to have some fun at my expense, and he got right up.

"Ladies and gentlemen," he began, "our friend Joe, the music-master, has consented to give us a recital."

That gave the boys a good laugh. And some of them got on either side of me and with mock dignity started to escort me to the piano. I could hear a girl say, "Oh, let the poor fellow alone; can't you see he's mortified to death."

The Last Laugh

I smiled to myself. This was certainly a wonderful setting for my little surprise party. Assuming a scared look, I stumbled over to the piano while the crowd tittered.

"Play 'The Varsity Drag'," shouted Fred thinking to embarrass me further.

I began fingering the keys, and then . . with a wonderful feeling of cool confidence . . . I broke right into the very selection Fred asked for. There was a sudden hush in the room as I made that old piano talk. But in a few minutes I heard a fellow jump to his feet and shout, "Believe me, the boy is *there!* Let's dance!"

Table and chairs were pushed aside, and soon the whole crowd was shuffling around having a whale of a time. Nobody would hear of my stopping, least of all the four fellows who were singing in harmony right at my elbow. So I played one peppy selection after another until I finished with "Crazy Rhythm" and the crowd stopped dancing and singing to applaud me. As I turned around to thank them, there was Fred holding a tenspot right under my nose.

"Folks," he said, addressing the crowd again, "I want to apologize publicly to Joe. I bet him he couldn't learn to play by mail, and believe me, he sure deserves to win the money!"

"Learn to play *by mail!*" exclaimed a dozen people. "That sounds impossible! Tell us how you did it!"

I was only too glad to tell them how I'd always wanted to play but couldn't afford a teacher, and couldn't think of spending years in practice. I described how I had read the U. S. School of Music ad, and how Fred bet me I couldn't learn to play by mail.

"Folks," I continued, "it was the biggest surprise of my life when I got the first lesson. It was fun right from the start, everything as simple as A-B-C. There were no scales or tiresome exercises. And all it required was part of my spare time. In a short time I was playing jazz, classical pieces, and in fact, anything I wanted. Believe me, that certainly was a profitable bet I made with Fred."

What Instrument for You?

Piano
Organ
Violin
Banjo
(Plectrum, 5-String or Tenor)
Clarinet
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Harp
Cornet
Piccolo
Guitar
Hawaiian Steel Guitar
Drums and Traps
Mandolin
'Cello
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Play Any Instrument

You, too, can now *teach yourself* to be an accomplished musician—right at home—in half the usual time. You can't go wrong with this simple new method which has already shown over half a million people how to play their favorite instruments *by note*. Forget that old-fashioned idea that you need special "talent." Just read the list of instruments in the panel, decide which one you want to play and the U. S. School will do the rest. And bear in mind no matter which instrument you choose, the cost in each case will be the same—averaging just a few cents a day. No matter whether you are a mere beginner or already a good performer, you will be interested in learning about this new and wonderful method.

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Thousands of successful students never dreamed they possessed musical ability until it was revealed to them by a remarkable "Musical Ability Test" which we send entirely without cost with our interesting free booklet.

If you are in earnest about wanting to play your favorite instrument—if you really want to gain happiness and increase your popularity—send at once for the Free Booklet and Free Demonstration Lesson which explain this remarkable method. The booklet will also tell you all about the amazing new *Automatic Finger Control.* No cost—no obligation. Sign and send the convenient coupon now. Instruments supplied when needed, cash or credit. U. S. School of Music, 812 Brunswick Bldg., N. Y. C.

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7x40-inch Handi-Lathe.
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Universal Jig Saw.
Universal Handi-Saw.
2 Motors, double shaft, 1/3 H.P. each.
3x8-foot Bench with legs.
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Not illustrated. Universal Handi-Saw, 7x10-inch Handi-Lathe, Jig Saw, one 1/3 h.p. double shaft motor and 3x6-foot bench with legs.
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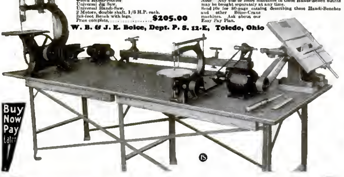
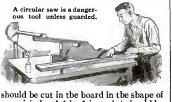


Safety Cover for Circular Saw

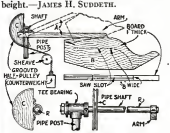
TO COVER a circular saw that is not provided with a commercial guard, it is possible to construct a convenient device for shielding the blade as shown in the accompanying illustrations.

From a 1-in. board, saw out a piece resembling the part marked *B* in the diagram. The size will depend upon the saw for which it is to be used. A ⅜-in. groove deep enough to accommodate the saw should be cut in the board in the shape of a semicircle. A 1 by 1 in. rod *A* should be fastened to this piece as shown.


A circular saw is a dangerous tool unless guarded.

For the half-pulley *C* prepare a semicircle of 1 in. thick wood with a 5-in. radius and on the edge cut out a groove for a small rope. Then attach this piece to a pipe or rod, the length of which will be determined by the installation. To the other end of the rod attach the arm and guard (*A* and *B*).

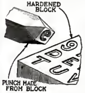
A rope is secured to *C*, and a weight is attached to the end of the rope so that the protector will swing up out of the way by itself when once it has been lifted about halfway. A stop of some type may be arranged to check the movement of the guard when it is raised to the proper height.—James H. Suddeth.



The assembled saw guard and details of the bearing for the rotating shaft, pulley, and arm.

Steel Stamp Master Block

STEEL punches, numerals, letters, trademarks, or designs of any kind can be duplicated quickly and inexpensively, provided an impression of them has been preserved in a block of annealed steel. This master block is hardened and the stock for the new punches is driven into the depressions. Each punch requires only a little touching up before it is ready to be hardened, and tempered, and put to use.



The punch is driven into the steel master block.

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With it, you can force door and window frames back to their original position and avoid having sash or doors planed or locks reset. You can raise the end of a radiator, kitchen sink, ice box or piano—or clamp or straighten glued furniture, drawers, radio cabinets, and hundreds of other jobs. It's called

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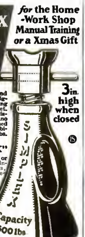
City————State————
Mark color desired: Red, Blue, Green
☐ Check here if you would like to receive a catalog of Simplex Jacks.



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This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

IVORY is becoming scarcer and scarcer as time goes on, so that those of us who are fortunate enough to possess ivory objects should take care to keep them beautiful by periodic restoration of the natural tint.

Objects cut from ivory that have become discolored can be restored to their original condition of beauty by any one of the three methods to be described.

All ivory has the tendency to turn yellow or even brown—either as the result of age and exposure to oxidizing influences, like heirlooms in the form of delicate carvings; or in much shorter time, through contact with greasy or perspiring hands and immersion in hot, greasy dishwater, the almost invariable fate of knife and fork handles.

OIL OF TURPEN.

The ivory to be bleached is placed in a wide-mouthed bottle containing oil of turpentine.

One method, which may be applied to nearly all ivory objects excepting piano keys, has been tried out with great success in many art museums. The ivory objects to be bleached are placed in a wide-mouthed glass jar and oil of turpentine poured into the jar so as to cover all of the ivory, but not the metal parts of knives, forks, and umbrella sticks, nor the wooden parts of canes. Care must be taken that the oil of turpentine does not penetrate to and dissolve the cement, which holds the tang of the knife or fork in the handle, and usually consists of a mixture of pitch or some resin and brick dust. The mouth of the jar should be covered with a bladder membrane and the whole container exposed to the sunlight for from one to two weeks.

Another method, particularly suitable for knife and fork handles, umbrella handles, and similar ivory objects, is to immerse them in a mixture of one part of peroxide of hydrogen and two parts of water for from one half to one hour, if necessary even longer, until the ivory is sufficiently bleached. Then polish them

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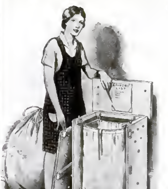
by briskly rubbing with a woolen cloth.

If the ivory has become yellow through handling or contact with dishwater, it is advisable to begin by immersing in alcohol, gasoline, or carbon tetrachloride, and after drying, rub vigorously with a rag dipped in 3 percent peroxide of hydrogen or a 5–10 percent solution of citric acid. After the bleaching is completed, the ivory should be rinsed with clean water and then rubbed dry. If the ivory forms the handles of knives or forks, care should be taken to protect the metal parts by coating them with vaseline and then wrapping them with paper to prevent the grease from spreading. If necessary, this process can be repeated two or three times. The whiteness of piano keys can also be restored by this process.—E. WELLECK.

Laundry Case with Removable Bag

THE case illustrated, aside from being an attractive receptacle for soiled linen, has the added advantage of being so constructed that the full, heavy laundry bag can be removed easily by taking out the front of the holder. No heavy lifting is necessary.



By removing the front, the tied bag can be easily taken out and an empty one hung in place.

For the family that is now stowing its soiled linen and clothing wherever it will best be out of sight, this case would be a much appreciated addition to the house furnishings.

The sides may be made of ½-in. boards glued to give the required sizes; but to avoid danger of warping and splitting and to insure strength, we will assume that ½-in. plywood will be used. Cut the back and the front 18¾ in. wide, the two ends 11 in. wide, and all 29½ in. long. These widths will allow the pieces to be cut from plywood 30 in. wide, which is a stock size. Make two cleats *A*, ¾ by 1¼ by 9½ in. and three cleats *B*, *B-1*, and *B-2*, ¾ by 1½ by 17¾

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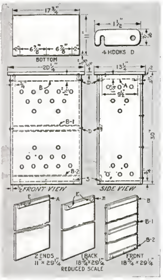
A definite program for getting ahead financially will be found on page four of this issue.

in. and bevel them ¼ in. as shown. Bore ⅜-in. holes for dowels in cleat *B-2* and fasten all cleats with glue and brads. Bore 1-in. ventilating holes as indicated in all sides. Make the bottom ¾ by 11 by 17¾ in. and the top ¾ by 13¼ by 20¼ in. Fit and glue pointed ⅜-in. dowels in *B-2* and bore holes in the front of the bottom to receive them.

Assemble with brads through the back and ends into the bottom and with screws through the back, for brads alone will not hold so well. Fit the front in place. Make or buy four flat brass hooks *D* and fit in place with ¾-in. No. 10 roundhead screws, filing their points off where they come through the ends. Hang the top with 2 by 1¼ in. butts (hinges) as at *2* in side view. Fit and glue a ⅜-in. pointed dowel in cleat *A* of each end and bore a corresponding hole nearly through the top to hold the top front corner of the ends in place when the front is down.



Assembly drawing of the case and details of the construction of the front, the back, and sides.

Prepare two cloth laundry bags that will fit the case loosely, making them about 1 yd. high to allow for a draw string in the top edge. When a filled bag is sent away, an empty one may be put in its place. To remove the bag, tie the draw string, close the cover, raise hooks *D*, draw the top of the front forward, lift the dowels in *B-2* out of their holes, and pull the bag out through the front. Replace the front, lift the cover, and put in the empty bag. Hooks placed at *E* and corresponding rings or loops on the outside of the bag will be convenient in keeping the bag open. Pieces of tape or wide rubber bands fastened to the inside of the cover to hold laundry lists will constantly remind each one to record daily deposits.

The case may be painted or lacquered in attractive colors. Four casters or polished steel glides may be placed in the bottom to move the case about.

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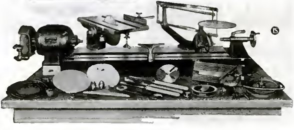

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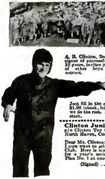
Above are a few of the many model designs you will make under this Club Plan.



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Send typewriter checked above for 10 days' Free Trial. I am enclosing $1 deposit with understanding that it will be returned if the typewriter is not satisfactory. If I keep it I will pay $3 a month until $44.90 [term price] is paid.

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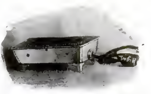


Toaster made from an aluminum pan, asbestos, wire mesh, resistance wire, and small fittings.

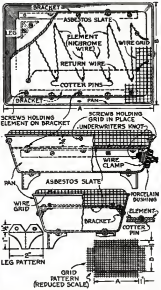
Simplified Electric Toaster Built at Low Cost

THIS inexpensive electric toaster was designed by E. A. Rerucha, of Wakefield, Mich., and won second prize in the electrical division of a national shop problem competition for teachers conducted by the Educational Department of POPULAR SCIENCE MONTHLY.

The base of the toaster is made from an aluminum pan of the type that can be bought in any hardware store. The pan indicated in the drawing is 6 by 9 in., but the only dimensions given are those that are fairly constant.

The legs are cut from No. 14 or No. 16 gage sheet aluminum and are bent into shape on the dotted lines shown on the pattern drawing. They can be fastened to the bottom of the pan with small tinner's rivets or by using No. 4-24 machine screws and nuts.

The heating element is made from 18 ft. of No. 25 nichrome resistance wire, coiled by winding it around No. 12 iron wire. This coil is mounted on asbestos slate ⅛ in. thick, as shown. Two binding screws are placed at each end for use in



Assembled toaster and grid and leg patterns.

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Canadian Factory: 338 Notre Dame East, Montreal

connecting the attachment cord, which is 5 ft. of No. 16 or No. 14 asbestos-covered heater cord. In attaching the cord, an underwriters knot must be tied next to the bushing. Be careful to leave enough slack so that there is no strain transmitted to the binding screw connection.

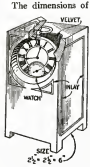
The grid can be made from No. 21 hardware mesh or cloth. Cut it to shape and bend as indicated. The grid should fit snugly inside the pan top, and the sides when bent down should rest on the asbestos plate. To obtain the best results the position of the grid will have to be determined by trial. To fasten the grid in place after the proper position has been determined, solder a small nut in the middle of each side of the grid and fasten it to the sides of the pan by means of screws.

This description is a condensed version of Mr. Rerucha's article which, with the drawings shown, formed his prize-winning contribution.

Small Clock Case for Holding a Watch

By setting an ordinary watch in this artistic little case made from a single block of mahogany or other hardwood, an attractive, serviceable traveling or desk clock can be made. The case is 2½ in. square and 6 in. long. It is cut out at the top as indicated, so as to leave an ornamental triangle of wood, which conceals the projecting stem of the watch.

The dimensions of the slot and hole for the dial must be adapted to the particular watch to be used, although the slot should be a trifle large so that it may be lined with soft cloth. Directly through the opening for the dial, drill a hole back into the block about the size of the dial opening and ⅜ in. deep, and pack into it some cloth or felt, which will act as a spring and hold the watch firmly in place, tight against the rim.



The case is made from a solid block of wood.

The case can be stained and finished with shellac, clear lacquer, or varnish. In the original model a saturated solution of permanganate of potash was applied, and a red cherry wood stain was then used. After this was dry, several coats of shellac were applied and well rubbed down.

A plain inlay of holly or other white wood, if placed as shown, will add to the beauty and decorativeness of the finished product.—Samuel Gore.

A rectangular piece of ordinary screen wire or wire mesh bent at right angles makes an excellent rack for holding and drying small parts that have been freshly painted.—C. B. W.

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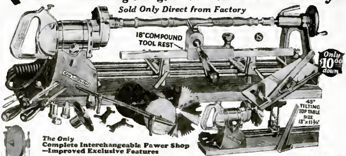

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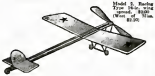
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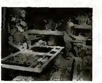

Carpenters want this light, electrically driven tool because it eliminates tedious hand sanding and finishes doors, cabinets, sash and similar jobs 5 times faster.

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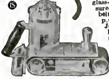

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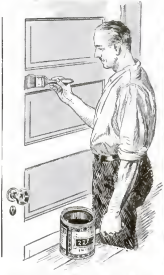
Hints on Handling a Paint Brush Skillfully



Use a paint brush with a moderate, even pressure keeping the hand directly over the brush.

SKILLFUL handling of a brush and thorough brushing-in of the painting materials are the fundamentals of painting. To these the amateur should give close attention, because they largely determine the success of the work; provided, of course, that high-grade paint and first-class brushes are being used.

To hold and use a paint brush improperly wears off the bristles and destroys or damages the shape. Generally speaking, a brush should be held lightly and firmly with the narrow part of the handle between the thumb and the first two fingers, much as a pencil is held in drawing lines with a rule. It should be used in such a way that it wears down uniformly and keeps its original shape. Do not grip a brush by the stock with the thumb or fingers extending over the bristles, and do not bear down too hard on it.

Use a moderate, even pressure in spreading the paint, and a light, even pressure in finishing. The muscles of the wrist, which do most of the work, can be relieved by those of the shoulder.

While the brush is being drawn back and forth across the surface, do not let the hand lead, but keep it directly over the brush. Lift the brush from the surface before starting a return stroke. Poking or jabbing the brush into corners or cracks breaks off the valuable flag or split ends and ruins the bristles.

The flag ends are what makes a brush valuable. One unfailing test used by practically all professional painters in judging the quality of bristle in a brush is to spread the bristle stock into a fan shape, hold it up to the light, and look

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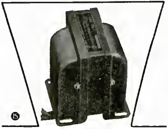

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Advice for POPULAR SCIENCE MONTHLY readers regarding safe and profitable investments. See Page 4.

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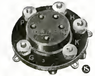

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for the flag ends on individual bristles. The professional knows that only a good brush has these valuable flag ends.

When a fine Chinese hog bristle paint brush has these flag ends, it is an ideal tool for brushing, but the amateur must use it properly so as to accomplish six results, as follows:

Penetration. Work the paint thoroughly into every fissure and crevice. Let the flags dig down into the surface, securing deep penetration of the painting material.

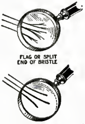
Surface Moisture. Every surface has a certain amount of surface moisture that must be thoroughly rubbed out.

Surface Tension. Because of contraction and expansion caused by changes in temperature, there is always a certain amount of surface tension. The strokes of a good bristle brush relieve this and the finishing material does not crack or wrinkle.

Air Bubbles. These must be thoroughly brushed out if a smooth, mirror-like surface is to be obtained.

Coverage. Only when the brush digs down into the pores of a surface—not merely slides across it—can proper coverage be obtained.

Adhesion. When well brushed, the paint becomes an integral part of the surface itself—not merely a "paint film" which will eventually crack and peel off.



The bristles of a good brush have flag ends.

The professional painter knows from experience that paint materials will produce a better surface and last longer when thoroughly rubbed into the surface. This applies to everything but lacquer, which should be flowed on the surface with a very full brush. Lacquer should never be backstroked or leveled off.

Too thick paint, varnish, or other materials will not harden properly and will tend to leave blisters instead of a smooth, glossy surface. Paint must thoroughly wet the surface to which it is applied, and the combined thickness of all coats should be just sufficient to harden and protect the surface.

Experience quickly points out the fatal mistake of attempting to paint with a brush that is not of good quality, absolutely clean, and the right size. The question therefore arises as to how to select a good brush. Paint brushes are of such a nature that they can be easily "doped"; that is, the mixture of bristle stock used may be blended with various adulterants, such as horsehair or vegetable fiber. The average person, when selecting a paint brush, will rely upon the recommendations of a dependable hardware or paint store.

When a painter is selecting a paint or varnish brush, he bends the bristle stock over the back of his hand to judge the flexibility of the brush and whether the bristles are springy and full of natural "oily life," as they should be. Next, he considers the length of the bristle stock,

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for that is one of the primary differences between a cheap brush and a good quality brush. The greater the amount of bristle stock, the more painting material it will hold and spread without redipping in the paint can.

Bristles make up, by far, the biggest single item in the cost of brushes, for the bristles alone cost anywhere from two to fifteen times the cost of the next largest component of which the brush is made. Bristles used in cheap brushes are usually left-overs after the best grades have been selected for the better brushes.

Next to the bristles, the most important construction feature of a brush is its setting. This is the trickiest feature of a brush to judge, and even a professional painter depends upon the judgment of the paint dealer or the reliability of a brush manufacturer.— R. E. Alexander.

New Colored Pencils Aid in Ship Model Work

For applying delicate decorations on ship models, for coloring flags, pennants, shields, and various ornaments, and for marking out minute panels, windows, and doors, a new type of colored indelible pencil can be used with far greater ease than a paint brush.

The pencils, which are made in twelve colors including black, have thin leads so that they can be sharpened to fine points and used like ordinary drawing pencils. They make possible the drawing of the finest lines and the most elaborate ornaments.

When the decorations have been applied and shaded as desired, a fine camel's-hair or red sable brush is dipped in water and used to blend the individual pencil strokes together wherever necessary, giving the effect of exceedingly clear and delicate painting.

On woodwork and metal parts it is necessary, of course, to apply a ground coat of flat white, light gray, or light brown paint as a foundation for receiving the colored ornamentation. On cloth flags the pencils are used without any preparation, and no further treatment with water is necessary, as the strokes blend together very well; on paper flags and pennants, however, the brush and water treatment is necessary.

Any surfaces decorated in this way can be given a protective coating, if desired, by spraying on very thin shellac or artists' fixative. It is possible even to brush on a coat of thin shellac without disturbing the colors if a very soft brush is used and the work is done very quickly.—L. T. G.

Caring for an Oilstone

To keep an oilstone in condition, use a good grade of mineral oil, wipe the stone off when you are through with it, and keep it in its case or at least in a place where it will be free from dirt.

The surface of a worn oilstone may be dressed to a plane surface on the side of a grindstone, or it may be rubbed down with an emery brick. Another method is to tack a sheet of emery cloth to the bench-top and rub the stone back and forth upon the cloth, stopping now and then to clean the dust from the cloth.

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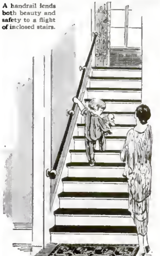
Rope Handrail for Inclosed Stairs

For stairs that are inclosed by two walls, a graceful and serviceable handrail can be made from 1¼-in. cotton rope, velvet, and a few brass stanchions of the type having a hole all the way through and sold by marine dealers. The stanchions should be brass, preferably 3½ in. high with a 1¼-in. hole and a 3-in. base. Polish and wash them thoroughly, and, when they are dry, apply a coat of clear lacquer.



A handrail lends both beauty and safety to a flight of inclosed stairs.

Mount the stanchions except one at top or bottom with 2½- or 3-in. screws. In determining the length of the rope allow about 18 in. at each end for a knot, which is made in "Turk's head" or "turhan" fashion.

Cover the rope with velvet, knot one end only, thread the rope through the stanchions, pull it tight, and mark it just where the knot on the free end should come. Tie the knot after threading the free stanchion on, and put the stanchion in place. Velvet can be sewed over the knots at both ends.—Samuel Gore.

Coconut Converted into Novel Table Lamp

A picturesque and unusual table lamp can be made as illustrated on the following page from a large, unhusked coconut and some palm stems or shrubbery.

The coconut is sawed in two and the meat removed, after which the nut is dried for several days. The stem half is used for the base, the stem being cut off and a hole bored through the shell

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A definite program for getting ahead financially will be found on page four of this issue.

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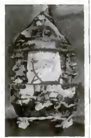
for the electric cord. An ordinary lamp socket is connected to the cord and secured in the shell with plaster of Paris.

Three 4½ in. long pieces of palm stem or shrubbery (the rougher and more irregular they are, the better the effect will be) are glued in small holes made in the husk to join the two halves together as shown. Three small pieces of the same kind of wood are glued to the bottom for feet.

A small ten-cent lamp shade is fastened to the globe by a wire clip, or a shade can be made from a strip of oiled parchment or mica on which any desired design may be stenciled or drawn. Care must be taken to leave an air space both above and below the shade, for ventilation.


The finished coconut shell electric lamp.

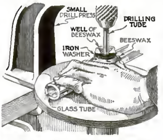
The lamp is trimmed with pieces of vine and the smallest of pine cones, which are fastened to the outside of the husk with small brads and glue. Flowers may be made by breaking up large cones and using the parts for petals.

The exposed fiber where the husk is cut into is filled with putty or clay and the whole varnished.—C. R. MCCASHLAND.

Guide for Drilling Glass

WHEN the tube method of drilling—or, more properly, grinding—glass is to be used, the most difficult part of the work is starting the drill. An efficient guide can be made from a cut iron washer with a hole slightly larger than the drill tube. A bit of beeswax is melted and poured on the place to be drilled, and the washer is pressed into it.

The surplus wax is removed from the hole in the washer and, with a little additional wax, is formed into a funnel-like well about the drill. The well is filled with turpentine or water, and the drilling proceeds as usual (see "Drilling Holes in Glass," P. S. M., May '29, p. 98).



An iron washer and a little beeswax serve as a guide to facilitate drilling holes in glass tubing.

This method of making a guide is easily applied to flat sheets or to convex surfaces and gives rigid support at the cutting edge of the drill.—FRANK E. GRAY.

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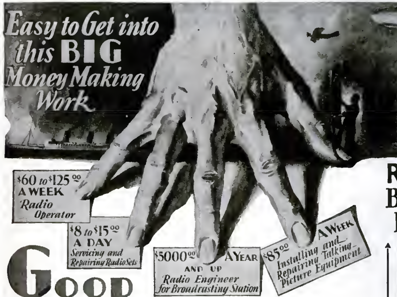
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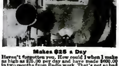
You may be interested to know that I am now Radio Service Manager for the H. N. Knight Supply Co. who are distributors for Eveready Radio Receivers in the State of Oklahoma, and Texas Panhandle, with an increase in salary of about 33 1-3%, since I enrolled with your school.

Thanking you for your interest you have shown in me, and your wonderful course, I am, EARL P. GORDON, 818 East 6th St., Oklahoma City, Okla.



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Haven't forgotten you. How could I when I make as high as $25.00 per day and have made $600.00 in two months from Radio work. That's not so bad when I'm only 19 and in a small town. I just looked over the catalog you sent me before I enrolled, and you did about all you said you would and about as much more.—FLOYD KNISELY, R. F. D. 2, Box 91, St. Joe, Ind.

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Where the New Motor Cars Excel

(*Continued from page 76*)

drive would be through all four of the wheels.

Kellogg silently thumbed through the catalogues for a while and then he popped another question. "What is a down-draft carburetor, Gus?" he asked.

"That's the latest," Gus replied. "The air flows down through the carburetor into the cylinders, instead of uphill. The air doesn't have to lift the gas particles uphill and the air velocity can be a lot lower. That allows a larger opening through the carburetor, which means more power at high speed, and still the mixture is right when the throttle is nearly shut. If they put the same big air passage in the ordinary carburetor to get the same top speed, the air would go through so slow when the engine was throttled that it wouldn't carry up enough gas. It's a swell idea. I wonder why somebody didn't think of it before."

"Humph!" grunted Kellogg. "Maybe the new cars have more power, but what have they done to make 'em last longer? I'll bet a new car wouldn't give me the service I've gotten out of this boat."

"WELL, let's see," Gus ruminated. "First off, they're doing a better job of making cylinder castings now than they used to. The new nickel-iron alloys wear better than the old gray iron castings. Also, they know more about how to design a cylinder block so the cylinder walls won't warp out of round as bad as they sometimes did in the old days. Then there's the crank shafts—they're grinding 'em more accurately and balancing 'em a lot better. Pistons are lighter; so are connecting rods. All that means less vibration, and less vibration means less wear.

"All the good cars now have thermostats to control the water temperature. The motor heats up quicker and even a careless driver can't run 'em much too cold in winter. There's less crank case dilution to spoil the oil's lubricating qualities and the oil filters they're fitting keep the oil clean. Air cleaners keep dust out of the cylinders, and that cuts down the carbon quite a bit. Higher compression means better economy.

"As for looks, the modern lacquer finishes stand up three times as long as the old paint finish, and the chromium plating on the bright parts stays bright without polishing."

"Gosh!" Kellogg exclaimed. "I thought all that stuff was just talking points. But even if it is true, how about the bodies they're putting on the cars these days? They look pretty light and tinny to me. The body on my car is better right now than most of the bodies on the new cars."

"That isn't a fair comparison," Gus objected. "I think the bodies they're fitting now are remarkable considering the price. You can't expect a fine hand-built coach job for a hundred dollars or so. It costs that much for one good upholstered chair from a furniture store. If you want to pay the price you can get as fine a body now as you ever could in the past. Your car cost a lot of jack. You can get as good a body for less today."

When the brakes had been lined and adjusted to Kellogg's satisfaction, he smiled rather sheepishly. "Mind if I keep these catalogues for a day or two?" he said. "I've kind of a notion I'll go the rounds with this old war horse and see what they'll allow me on a trade-in."

ARE you up against some motor car problem that is causing you trouble? Gus and Joe will be glad to answer any reasonable questions on the subject of automobiles. Simply state your questions in a letter to Mr. Bunn in care of POPULAR SCIENCE MONTHLY, 381 Fourth Avenue, New York, N. Y.

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NATIONAL AUTOMOTIVE

Fossil Monsters I Have Hunted

(Continued from page 57)

of the duck-billed dinosaur, *Trachodon*. I flopped carelessly on a ledge of sandstone to rest for a moment, only to leap up quickly with a long tear in my trousers and a cut in my leg. The very end bone of the fossilized tail of some prehistoric monster had pierced me. Following it back, I found the finest specimen of a *Trachodon* yet unearthed. Four of us worked ceaselessly for two and a half months excavating this monster, the skull of which, alone, was more than four feet long. The entire specimen weighed approximately five tons. It was shipped to the Senckenberg Museum, Frankfort-on-the-Main, Germany, where it now is.

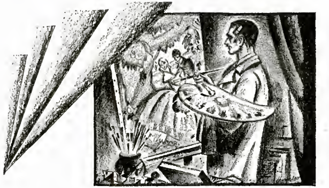
THIS great lizard, weighing probably ten tons when alive, apparently had been trapped in quicksand and had sunk to its death, for the front limbs were lifted up along the sides of the body, and reversed, revealing the perfectly preserved webs which had covered the feet. The head and neck were stretched to their full length, as if the *Trachodon* had been struggling to escape the grasping sands, while the hind feet were pointed downward, showing an effort to swim out. Most remarkable of all, the entire body was covered with skin, not clinging to the bones, but well filled out, as if by the rounded muscles of life. The sand had taken the place occupied by the flesh in life, and thus, for the first and only time, we had an opportunity to see and study the exact form of a dinosaur, not the imagined form of a restoration.

We had not the proper lifting equipment—tripods, blocks, lines, and hooks—with which to handle the great weights of the three sections, some 3,000 pounds each, into which we cut the stone block containing the skeleton. But with simple machinery made from two stout cottonwood poles and two blocks of the same wood, we could raise a section a few inches off the ground and hold it there while others of the party shoveled sand beneath and tamped it hard. Thus, in a week, we raised one section some four feet into the air so that a wagon could be backed under it. Then, by placing cottonwood rollers in the bed of the wagon, we shoved the block of stone aboard and hauled it to the railroad station, many miles away.

Accompanying the blocks of stone to the museum is a detailed map of the location of the find. This map is made by the fossil hunter on the spot. Photographs are also sent to complete the information that guides the preparator in assembling the skeleton. When the blocks of stone have been unpacked, a colorless, thin, but very penetrative cement is poured into the exposed ends of the bones, from which the organic material, of course, has long ago disappeared. This is allowed to "set" until every small particle of fossil bone is bound firmly together. Then, with power drills and chisels, the sandstone is cut away, the plaster of Paris packing having been removed by the simple process of unwinding the burlap strips.

AS THE stone is removed to the areas penetrated by the cement, more cement is applied until eventually the brown bones, each solidified by the cement, stand clear of as much of the stone as the preparator desires to remove. Some skeletons, particularly those found in perfect conditions, are mounted "flat," in the slabs of stone in which they were discovered. Others, which may have been distorted by the pressure of the sand in process of petrification, have to be removed, placed in their proper positions, and set up on steel tubular frames. This is particularly true of the larger dinosaurs, mammoths, prehistoric rhinoceroses, and the vari-

(Continued on page 140)



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Fossil Monsters I Have Hunted

(*Continued from page 139*)

ous forms of the early horse. The "serpents" and other swimming lizards, the fishes, and some of the smaller dinosaurs, are mounted in the "flat."

Frequently, in large specimens, bones will be broken and entire bones will have disappeared. It then becomes the duty of the preparator to rebuild the missing bones out of a specially-prepared composition, or to obtain the missing bones from other incomplete specimens of the same animal. Since this latter is seldom possible, the preparator must become an anatomist and a sculptor, if the fossil skeleton is to be complete. He first obtains from some other specimen a bone as nearly like the missing one as possible. Then he models a copy of this, and places it in its proper position in the skeleton he is mounting.

If he is unable to obtain such a bone, he must model one by reversing, in his mind, its mate on the opposite side of the skeleton. Two months of steady work sometimes is required to model and replace a single bone in a large skeleton, or to rebuild a shattered bone.

Reconstructions of the skeletons and bodies of prehistoric animals and reptiles have been made from a single bone or a solitary tooth, but at best this is uncertain. Some years ago, seven different and distinct prehistoric sharks had been identified and classified on a basis of one known tooth of each. In the ancient sea beds of Kansas, I found one fossil shark which contained all these seven kinds of teeth in its own jaw, proving that at least six of these restorations had been wrong.

It was along the petrified rim of this prehistoric sea in Kansas that one of the strangest of my accidental discoveries took place. I stooped to study more closely a group of fossil gastropods, laying aside my hand pick to do so. When I lifted the implement, the point had caught in the mouth of a long-buried skull just below the ground. Carefully working back toward the body, I uncovered the ancestor of all the sea-serpents, a *Tylosaur* about thirty feet long. This was a sea-living reptile, attaining a length of fifty feet or more, carnivorous, and probably the "tiger of the seas" five million years ago.

This interesting fossil lay with snout, all four flippers, and tail extended, just as it had been overwhelmed by an avalanche of sand while swimming unsuspectingly near the shore. The position of the skeleton told us the complete story of the character and habits of this father of all sea-serpent stories. There was no distortion, and the skeleton was lifted out in three slabs of sandstone, which were put together again, and the *Tylosaur* displayed like a picture in a frame.

We shall never know whence came the sand which overwhelmed and preserved this *Tylosaur*, but from the work of the sand we do know very closely the appearance of this strange swimming lizard in life. My studies of all the known forms of dinosaurs leads me to believe that some day we will find specimens which will change our conception of these animals. The dinosaur was a huge lizard, some varieties living on land, some in the water, and some impartially on both. Now, all known lizards, from the great saurians to the tiny chameleons, walk with their feet *outside* the line of the body and with the *belly dragging on the ground*. Some of them can, and do on occasion, stand erect on their hind feet, but this is not a habitual pose with any of them.

In the restorations of the dinosaurs in virtually all museums, the dinosaur is represented as standing on all fours, like a mammal, with the feet *inside* the line of the body, again like a mammal, or standing and running on the hind feet. In either instance, the belly—which was entirely unprotected and open to attack from the carnivorous dinosaurs—is lifted well up from the ground. Without studying the fossil skeletons in their positions in the rocks, the logical paleontologist would believe that these lizards should be pictured with their hind limbs curved out, like those of an alligator; the feet *outside* of, and at right angles to, the line of the body, and the belly close to the ground—exactly the posture of the lizards of today. My observations of the skeletons of a hundred or so dinosaurs, which I have discovered and excavated, confirms this belief.

What I consider my most important discovery in six decades as a fossil hunter is the finding of complete skin-impressions of a crested duck-billed dinosaur. Prior to this finding, there had been much discussion as to the character of the skin which covered the giant frames of these great lizards. In a rock-walled gorge, a mile wide and five hundred feet deep, in Alberta, Canada, I discovered the virtually complete skeleton of this duck-bill, *Stephanosaurus marginatus*. The small scales of the skin, often mere tubercles, polygonal in shape, were arranged like mosaic in a pavement in parallel rows, along the abdominal walls. Later, I found other impressions of the skins of other dinosaurs, and some fragments which are believed to be the actual skin itself, so thoroughly fossilized as to be almost indistinguishable from the impressions or "molds" in the stone.

This discovery enables us at last to picture with fair accuracy the external appearance of the dinosaurs of these varieties, and, as we know from the skeletal remains their interior arrangements, we now can present the complete duck-billed dinosaur of the crested or crowned species just as it appeared when it strode along the shores of the Cretaceous Sea, or swam in its waters.

The weapons of the fossil hunter are pick, crowbar, chisel, soft brushes, cement, burlap, and plaster of Paris. Sometimes, when he finds a skeleton projecting from the face of a cliff, he turns carpenter and builds a lofty platform on which to work as he removes it. Again, he calls in dynamite, and blasts his treasure unbroken from its natural sarcophagus of stone. There are not more than half a dozen of us, but I doubt if any hunter, facing a charging elephant or an angered rhino, ever felt any greater thrill than we do when we stumble upon a new variety of monster, possibly the remote ancestor of these big-game animals of today.

Diamonds—Skyscrapers Built of Atoms

(*Continued from page 50*)

of common salt. Like the crystals of granulated sugar, those of ordinary table salt are made purposely of a small and uniform size to facilitate solution and to make the salt flow easily. This is controlled by making the salt crystallize at a definite speed when it is being refined. For scientific purposes much larger crystals of clean, pure salt are grown artificially. From these are cut the prisms and lenses, for example, used in studying the invisible rays of infra-red light.

The distances of the atoms from each other in the unit cube of the salt-crystal have been measured with exceptional precision. These distances are almost unbelievably tiny. Imagine a crystallograph- (*Continued on page 141*)

Diamonds—Skyscrapers Built of Atoms

(Continued from page 140)

er possessed of a magic drug to enlarge things or to make them smaller. Suppose him to pour a dose of it over a small cube of pure salt a half-inch square, about the size of average dice. Let the drug enlarge this salt cube until one edge of it stretches across the United States from New York to San Francisco. In this gigantic enlargement the atoms will still be less than five inches apart in a continual, regular pattern across the United States and an equal distance up into the air.

THIS half-inch cube of crystallized salt, about as much as the average person eats in a plate of soup, contains more than eleven thousand billion billions of the unit cubes of the atomic pattern.

Most promising practically of all scientific researches on crystals is that concerned with metals. The strength and the weakness of metals are due, it has been discovered, to their internal crystals. On one hand is duralumin, the new, very strong alloy of aluminum, copper, and other elements which makes possible modern airships like the *Los Angeles* and the *Graf Zeppelin*. The strength of this alloy is due to myriads of tiny metal crystals scattered between its larger crystals of aluminum. These tiny grains keep the larger ones from sliding past each other and allowing the metal to pull apart. The same strengthening process occurs in some alloys of copper and other metals.

PURPOSEFUL control of crystal formations is the chief object of modern metallurgy. Much has been learned by melting and cooling different metal compositions and examining under the microscope the kinds of tiny skyscraper structures that form. Much more will be learned if the laws which control the arrangement of atoms in the unit patterns can be learned and their applications worked out.

Other properties of crystals have begun to be important, too, in other sciences. In radio, plates cut from natural crystals of quartz, or "rock crystal," vibrate mechanically when subjected to the back and forth electric swings of a radio circuit. These crystal plates are now used almost universally to keep radio stations precisely on their assigned wave lengths.

In optical instruments, quartz crystals are used, for example, to measure and analyze the rays of ultra-violet light now known to be beneficial to health, while crystals of Iceland spar and other minerals are used to study polarized light and to make the instruments for quick analysis of the amount of sugar in things like sugar cane. Examination of snow crystals promises to tell weather experts much about conditions in the upper air, far above levels which can be reached by balloons or airplanes. Artificial ice crystals made in the laboratory have disclosed facts previously unknown about the nature of so familiar a substance as water.

Examination of crystals under special microscopes has told experts in microchemistry the kind of drug contained in an empty medicine wrapper picked up by the police at the site of a suicide and murder. Similar observations regularly disclose to geologists conditions which must have existed when rocks were formed, like a specimen poured out thousands of years ago on the sea bottom of the Atlantic Ocean and dredged up by a recent scientific expedition.

To make diamonds larger than ostrich eggs has no great appeal to scientists. But thousands of scientific men willingly would give years of their lives to discover just why it is that the South African carbon atoms consented ages ago to crystallize in the atomic pattern of diamonds but are so reluctant to do the same thing nowadays in scientific laboratories.

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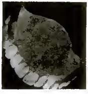

A New World Run by Dynamo

(*Continued from page 21*)

proved machinery for generating and transmitting electric current, it suggested a novel source of factory power to forward-looking engineers.

When the steam engine was invented there was just one way to carry its power to a distant place. That was with a belt or a shaft. An old-fashioned shop was a forest of pulleys. There was nothing like "central station" power. Imagine what a small town, even, would look like if power were transmitted from a central plant to factories by ropes and belts. But here was electric energy. It could be shot over small wires that could be bent around obstacles. There was little loss of power in transmitting it. Where it was used it could be transformed into other forms of energy than mechanical power—light, heat, and chemical energy used, for example, in electroplating. It was an ideal form of power.

SO THOUGHTFUL engineers, little by little, began to substitute it for steam and other forms of power in factories. They did it so quietly that the average person scarcely realized what was being accomplished. But today the world-wide revolution nears completion. English factories today are forty-eight percent electrified. German factories lead them with sixty-six percent electrification. But the United States tops the list with seventy-eight percent of its industry run by electricity.

Better ways of transmitting electric power over great distances, and huge power stations to generate it, have made the revolution possible. Not long ago the engineers of a 220,000-volt transmission line between Vaca and Pit River, Calif., wanted to find out what would happen in case the wires fell. They deliberately connected one of them to the ground and turned on the power. There was a crash and a burst of flame twenty-five feet high. Then the automatic safety devices operated and shut off the current before damage had been done.

Great electric companies have spent thousands of dollars photographing the effect of lightning strokes on transmission lines (see page 33). The result has been lightning-proof power lines hundreds of miles long to convey power safely to distant industries. Today 23,674 miles of transmission lines operate at voltages of 66,000 volts or more to deliver rivers of electric power across country.

ALONG with the electrical revolution came super-power. As early as 1910 a midwestern utility company made a daring experiment. Twenty-two small towns, with populations of from 300 up, were chosen as the group on which to try it. Ten of them had electric companies of doubtful financial standing, the other twelve none at all. The utility company first bought the existing power stations and closed them. Then it built transmission lines to all the towns and to 125 farms and hooked them to a few central stations.

It was the cheapest electricity the section had ever known. Twenty-three thousand small-town dwellers and farmers were suddenly treated to twentieth-century electrical service, and the section prospered with industry as never before. That successful experiment applied today on a much greater scale in many parts of the country is the beginning of the national super-power that engineers dream of—the vast reservoir of energy that can be tapped by a factory or a home anywhere.

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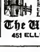

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The Moon Is Made of Cinders

(Continued from page 45)

high. Other ring mountains are almost as large and some are higher. No volcano on earth has ever constructed so gigantic a crater as this one.

The difficulty lessens, however, when one remembers the much smaller gravity of the moon, as compared with that of the earth. A firecracker on the moon would blow up a house, for all material things weigh much less there than on earth, as one result of the moon's smaller size and mass. Accordingly a given amount of volcanic explosion on the moon would throw far more material into the crater's ramparts and would shoot out this material to far greater distances than would be the case on the earth.

The darker, flat looking areas on the moon, which early astronomers named "seas" or "lakes" and which mostly form the Man in the Moon's picture, are probably places where a general blanket of volcanic dust and broken pumice settled more or less evenly as near-by eruptions ceased. Every feature of the moon's surface may be explained as the result of volcanic activity combined with weak gravity. Probably the volcanoes were of the type represented on earth by those of Hawaii, where a large, round crater is built up and its flanks sprinkled occasionally with pumice and volcanic dust, without eruptions of the enormously explosive type like that which destroyed, over forty years ago, the East Indian island of Krakatoa.

THERE is one part of the moon, it must not be forgotten, which no terrestrial astronomer has ever seen nor ever will see, until the projected moon rocket or some similar vehicle is a reality. This is the back of the moon, for the moon turns the same face continually toward the earth. There is no reason to believe, however, that the hidden side is notably different from the visible side. From time to time in its motions the moon tips slightly one way or the other and exposes glimpses around its edges. What they show is the same as the moon's front.

If the explanation of the moon's appearance is exclusively a volcanic one, the question arises whether all this enormous eruptive energy has altogether ceased. A renewed volcanic outbreak on the moon creating, for example, a new crater as gigantic as Copernicus or the other giant named Tycho, would form a remarkable spectacle for the earth. That is scarcely probable, but there are minor evidences of waning moon fires.

The apparently flat floor of the lunar crater named Plato shows changes of color from time to time, perhaps due to shadows, but ascribed with greater plausibility to vapors escaping from the mountain walls or from fissures in the floor. Professor W. H. Pickering, formerly of Harvard but who now has a private observatory in Jamaica, recently called attention to the fact that the lunar crater named Stevinus sometimes appears as though its floor were luminous and of a brown tint.

PERHAPS the best observation of apparent changes on the moon has been made by a French amateur astronomer, M. G. Bidault de l'Isle, of La Guette. Between August, 1927, and September, 1928, this patient observer watched on every clear night a small, volcano-like peak which projects above the smooth floor of the larger crater named Posidon, located between the two dark lunar areas called, poetically, the Sea of Serenity and the Lake of Dreams.

At times, M. de l'Isle reports, this tiny craterlet, less than a terrestrial mile in diameter, seemed as clear and sharp in outline as any other feature of the moon. At intervals, however, it was in-

(Continued on page 144)

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The Moon Is Made of Cinders

(*Continued from page 143*)

visible, apparently obscured by some kind of cloud or mist. On a few occasions, when the sun's rays fell just at the right angle on this apparent cloudlet, it seemed to be shining by reflection, as a cloud of steam coming out of one of the Yellowstone Park geysers might look to an aviator many miles above the earth.

Such observations suggest that there are still active on the moon a few small volcanic vents, like hot springs or geysers on earth. Doubtless the new giant telescope which is projected for erection in California and which will bring the moon's surface to within an apparent distance of about twenty miles from the earth, will disclose further details. Meanwhile, it is reasonable to imagine that the moon, although dying, is not quite dead. Perhaps it still has important secrets to tell.

It is not even certain that the moon utterly lacks life in the sense of living creatures. Several years ago Professor Pickering, the same who referred recently to the apparent changes in the craters, reported what seemed to him to be moving shadows on the moon's surface. He suggested the possibility of herds of migrating animals, perhaps like the migratory grasshoppers of earth. There is little evidence for this, yet to deny the possibility of moon life is even more foolishly dogmatic than to assert its existence. Air and water, it is true, are lacking on the moon, unless the vapors which M. de l'Isle believes that he has seen contain some water. But there are creatures even on earth which can live with an incredibly small supply of water or air. There is no doubt that airless life forms would have developed on the moon had life started there from a germ as on earth and continued its evolution to suit lunar conditions instead of terrestrial ones.

ASSUMING this living moon germ of the same kind as the earth germ, perhaps even derived from the earth when the substance of the moon was torn away, it is possible to imagine what any present moon creatures would be like. A hard outer shell they must have, like terrestrial crabs and insects, to prevent loss of bodily fluids into airless space. Energy they would obtain, it is probable, by absorbing sunlight, perhaps through contrivances like eyes which could turn sunlight into food, somewhat as plants do on earth. For the substance of their bodies, the moon creatures might depend on mineral elements like silicon and iron in the pumice of the moon's surface, decomposing this powder, perhaps, by acid gases excreted from their bodies underneath tentlike appendages closed down on the soil to protect the ensuing chemical operation from the vacuum of space.

THE bodies of the moon creatures would be slim, jointed, and very light, to suit both the soft surface of the moon and the lesser gravity. There might be pads, like snowshoes, on the creatures' feet, to walk on the loose dust. Water must be one of their necessities, at least in minute amounts, for the life-germ of earth has never developed without enough water to keep its living protoplasm partly liquid. But a little water probably is still available on the moon in the gases from the dying volcanic vents. One might imagine the strange moon creatures collecting around these openings at the proper moment to catch the precious vapor by contrivances like the gills of a fish. From these volcanic gases they might obtain, too, the acids necessary to decompose pumice of the soil for food.

Fantastic as such a picture of moon creatures may seem, baseless as it is in anything except speculation from the known facts of life's history on earth, it is not impossible. Perhaps, some day soon, larger telescopes will disclose whether any of it is true.

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"How I Fly My Plane"

(Continued from page 48)

except special flights. A magnetic compass is easily compensated, or set at true north, by means of screws which shift the magnets farther from or nearer to the needle.

If a pilot follows a highway for any distance, he can see plenty of accidents. Every once in a while, two of the little black flies, crawling along the chalk line, can be seen bumping into each other. Sometimes, when the ceiling has been low, I have sailed along over farmhouses so close I could distinguish the color of flowers in little pots sitting on the back porches. After I go over a route several times, I begin to recognize people out in the back yards.

I remember one time I was flying low over the mountains of the South. A little clearing appeared below. Paths spread out from it in all directions. I circled around to see what was going on. The result was a couple of bullet holes in my wing. Those moonshiners were taking no chances!

But being shot at from the ground is play compared to dodging lightning in the sky. I have been up in electrical storms so severe that everything got as black as midnight and little blue sparks played all over the bracing wires of the Waco biplane I was flying. Once a thunderbolt hissed so close it seemed to miss the wings by inches. In the air you don't hear thunder, you just see the flash.

THE ground below, on a cross-country flight, spreads out like a patchwork quilt. Each patch is a field. If the motor calls it a day and quits suddenly, the question always is, which patch to land on. In a forced landing, the best rule is: "Pick your field as soon as possible—and don't change your mind."

There are certain things to help in the picking. For instance, fields with cattle grazing in them are likely to be good landing spots. By studying the colors of different crops from the air, a pilot can learn to spot fields with growing crops too tall for safely setting down a ship. High grain and grass can be recognized by the ripples a breeze makes sweeping across it. Approaching a field, it is often possible to see spots greener than the rest. They are depressions or damp places, to be avoided.

In winter, except when fields are covered by snow, there is a better chance to see what the ground is like than in summer. In setting a ship down in a field that requires an uphill landing, the plane is flattened out almost into a stalling position, with the tail well down, just before touching. I always avoid downhill landings whenever possible. They too often mean nosing over in a somersault.

THE hardest part about landing is judging distance. I've found a pilot is likely to overestimate distance in landing in bad light or when the field and background are of the same dull color. He is likely to underestimate it when the light is good or when he is coming down with the sun at his back. In poor light, he oversboots the field, or reaches it before he has lost speed and altitude. In good light he frequently undershoots it. When he sees his glide is carrying him too far, he can sideslip off some of his speed and altitude. But if he undershoots, the only thing he can do is to slap on the throttle and climb for another try. For this reason, it is well to come down with the motor idling, or to "blimp" it on and off at four or five second intervals. If a pilot comes down with the switch cut and undershoots, the motor may not start when he needs it—and needs it bad.

As I come in, when the ship nears the ground, I usually keep (Continued on page 148)

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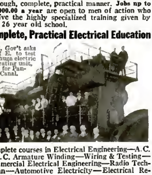
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"How I Fly My Plane"

(Continued from page 145)

my eyes on the field about thirty yards ahead of the plane. The moment the wheels touch is the critical one. Twenty feet up, a ship may have one wing low or be sideslipping all over the place. That is forgiven if she straightens out before the wheels touch.

Out in Missouri, I once had to bring down a ship in the dark with half the landing gear gone. I was flying home at dusk when the motor quit over an orphan asylum. I sat down in the front yard and got the engine going. When I took off, a snag of a dead pine that stuck up ten or twelve feet caught the axle and ripped loose one wheel. I circled around a while wondering what to do. Then I headed for a cornfield where I knew the ground was soft, sideslipped the plane down, and landed on the one good wheel. The whole gear crumpled under the weight, but otherwise the ship wasn't even scratched.

I HAVE often thought of what I would do if I ever should find myself in the air with both landing wheels gone. To save the ship, I think the first bet would be to set her down in water. Next best would be to make a sharp dip, striking a hard-packed field with the landing gear struts, wiping them off, and then come down, scooting the machine over the ground like a sled on the bottom of its fuselage. But I don't care to carry out that experiment if I can help it!

Put end to end, my hours in the air would make practically half a year of continuous flying, night and day. Yet, I learn something new on every cross-country trip. In aviation, for thrills and the possibility of increasing piloting skill, the sky's the limit.

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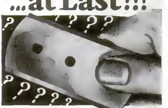

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Back of the Month's News

(Continued from page 55)

Probably not more than a score of persons in the world ever saw a sample of pure manganese, but everybody sees and depends upon an article for which manganese is essential. This is modern steel. One of the first great uses of steel containing manganese was to make "tin hats" in the war, but nowadays most of the steel used in industry contains a little of this element. Toughness of the metal is increased by manganese; brittleness is prevented; strength, working ability, and other properties are improved. Manganese is "medicine for steel," said C. P. McCormack, metallurgist, at a recent meeting of the American Institute of Mining and Metallurgical Engineers. A compound of manganese is used, too, in making dry batteries, but the steel business is where manganese is needed most.

Deposits of manganese ore exist in Washington, New Mexico, Minnesota, Montana, Virginia, and Georgia, but American mines have never been able to supply the entire quantity needed for American steel. That is why imports of manganese from Brazil are heavy. It is also why American interests have recently contracted for supplies of manganese ore from Soviet Russia.

In the iron ore regions of the Great Lakes much manganese occurs but, by a natural misfortune, the manganese minerals are so widely scattered through the ore that the recovery of manganese in useful form is very difficult. Recent experiments, however, have been promising; some by the United States Bureau of Mines, others by commercial interests. Some day soon, it is probable, American mineral deposits will supply the country's manganese demand—a most desirable outcome, since military officers estimate that lack of manganese would be one of the country's most serious handicaps in case of sudden war.

Water Fleas and Heredity

PICTURES of water fleas are being hung up nowadays in most of the world's laboratories of biology. For these tiny creatures are likely to prove among the most interesting, scientifically, in the world. Thanks to researches by Dr. Arthur M. Banta, of the Carnegie Institution, water fleas already have supplied one of the best examples of the operation of heredity, and almost the only example known to science of the artificial control of sex.

The water flea is not really a flea. It is a microscopic crustacean, belonging to the same great group of animals which includes lobsters, shrimps, and crabs. Water fleas live usually in fresh-water ponds which fill up in the spring and fade away to dryness in the autumn or early winter. To survive the winter the tiny creatures construct a special kind of egg, which survives dryness and cold, and hatches promptly in the spring. The hatched creature is a female. Under normal conditions, Dr. Banta finds, every one of this spring crop of the creatures is precisely like its mother. Heredity is perfect. Sometimes, however, there occurs what animal breeders call a "sport." Dr. Banta found one water flea which was able to live in water about ten degrees hotter than that which would kill its brothers and sisters. This variant creature bred true, its offspring having the same heat-resisting quality. Thus evolution may have proceeded to produce races of creatures able to live under new conditions.

In the society of the water fleas males play a small role, but they exist, especially in the fall, to fertilize the eggs. What causes males to be produced, Dr. Banta finds, is the crowding of the population of females as the pond begins to shrink. By the artificial overcrowding of mother water fleas, or by denying them enough food, they may be made to produce more males and fewer females; an important step, perhaps, toward better understanding of the phenomena of sex in other creatures also.

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Why Minds Behave As They Do

(Continued from page 29)

white robes of surgeons and nurses at emergency dressing stations, he said, adding that hysteria during the mental strain of terrific fighting made conditions ripe for "startling psychic manifestations."

A ten-year-old boy who mysteriously felt impelled to chew the lapels and sleeves of his coat, and a young girl of good family who for lapses of days or a week took on a different personality and associated with undesirable strangers, were examples of strange mental cases helped by psychoanalysis which Dr. A. A. Brill, of New York City, described. These troubles, he asserted, were eventually cured when their causes were discovered by Freudian methods. The boy, for instance, was found suffering from excessive "mothering" following his father's death, which produced a peculiar reversion to thumb-sucking and other tendencies of childhood.

In the young girl's case, her father's "rigid fanaticism" had given her a narrow morality so repressive that it produced a dual personality. Her "other self," during the lapses, loosed all the pent-up force of her repressed desires, in actions of which she would later have no conscious memory.

Psychoanalysis seems the only effective approach to the cure of such patients, Dr. Brill said, and its skillful application requires a complete knowledge of the patient's constitutional make-up and reactions.

Psychological interneships in general hospitals were urged by Dr. Mabel Ensworth Goudge, of Chapel Hill, N. C. Often the psychoanalyst and the physician must coöperate in treating a case of nervous disease or other disorder, she said, and in some cases a psychological cure is aided by the physician's drugs and physiotherapy.

Tests of Intelligence

"INTELLIGENCE tests," which began as measurements of ordinary brain-power, now determine an individual's "emotionality," "sense of humor," "personality," and even admissibility to a school of music, experts told the Congress.

The discomfort of a needle pressed into the palm of the hand, a peg pressed into the wrist, and an electric current flowing through the hand, formed part of a unique "torture test" given to a hundred students, and described by Prof. Thomas B. Howells, of the University of Colorado. It was designed to measure the students' persistence or "stick-to-it-iveness." The high scorers, who voluntarily endured the most discomfort, proved to be leaders in other intelligence tests, Professor Howells said.

Most persons assume they know the difference between "right" and "wrong" acts, said Prof. Vernon Jones, of Clark University. But when he asked 168 school-teachers to mark "right," "wrong," or "excusable" sixty-eight childhood actions suggested in a novel questionnaire, he found wide disagreement, he reported. One question was whether a child should shield friends he had seen meddling with a railroad switch, wrecking a train. On only twelve out of the sixty-eight questions did even ninety percent of the teachers agree.

Bible students, contrary to belief, are as likely to lie and cheat as anyone, Prof. P. R. Hightower, of Butler University, concluded after a test he gave 3,316 school children. The test offered eight chances to cheat, two to lie, two to show loyalty, and two for altruism and service. Other tests measured Bible knowledge for comparison.

The idea that intelligence always shows in a man's face is a popular myth, asserted Prof. Richard S. Uhrbrock, of Cornell University. He asked six hundred men and women to judge photographs of six *(Continued on page 149)*

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Why Minds Behave As They Do

(*Continued from page 148*)

of the highest and six of the lowest scorers in a recent intelligence test. Four of the twelve were wrongly called intelligent or nonintelligent. The photograph of a high scorer misjudged as "nonintelligent," particularly by women, showed a drooping mouth, a snarl, and averted eyes. But more women than men correctly classified as "intelligent" a pleasant-faced man smiling agreeably and looking straight at the camera.

Why People "Get Mad"

WHAT makes people angry was the subject of a novel study reported by Prof. Hulsey Cason, of the University of Rochester. He compiled a list of more than 2,600 different annoyances submitted to him by students, along with estimates of their relative disagreeableness. Among them were "someone reading my newspaper over my shoulder," "a person pushing in ahead of me in a waiting line," "audible conversation next to me at the movies or a music recital," and "being told to do something when I am about to do it."

"A person coughing in my face" received one of the highest scores as a source of extreme annoyance, as did the sight of a young person treating elders with disrespect or an adult abusing a child.

Jazz music, Professor Cason found, exasperates older persons more than younger ones.

Mind-Measuring Machines

A NEW vacuum tube machine, described by Dr. S. R. Hathaway, of Ohio University, gives criminal suspects a psychological third-degree. Tried out on 100 college women during an epidemic of stealing in a women's dormitory, it showed their reactions during conversation to words connected with theft. Other devices that test breathing or blood pressure also give a criminal away or trap him in a lie, but they should be used only by experts, Dr. Harold E. Burtt, of Ohio State University, stated.

Persistence of vision, the secret of motion pictures which lies in the eyes' ability to preserve the image of an object for a moment after it disappears, is strikingly demonstrated in a train of luminous flashes by a special type of neon lamp described by Dr. Walter R. Miles, of Stanford University. Motions of the hand in performing complicated movements are now being studied, said Dr. J. van der Velt, of the University of Rome, by attaching a tiny flickering lamp to the subject's finger. A dotted-line record is caught on a photographic plate.

One of the first machines ever devised to test a man's ability to judge relative speed helps select bus drivers in Barcelona and Paris, reported Dr. Emilio Mira, of Barcelona, Spain. Rods worked by electricity are started toward each other on a fifteen-foot table at different speeds. Subjects are asked to guess quickly at what point they will meet. Excellence in this type of judgment may save an auto driver from a collision.

Learning from Animals

AN "APE farm" is to be established in Florida by Yale University, its president, Dr. James R. Angell, revealed to the psychologists. At this farm the animals will be bred and raised in order to study the psychological and physiological problems of animals and human beings.

Even goldfish have helped psychologists, said Prof. Raymond B. Wheeler, of the University of Kansas. Forty of them, in tests, demonstrated their reaction to strong and weak light and showed smartness in choosing preference to either— (*Continued on page 150*)

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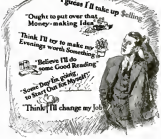
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Why Minds Behave As They Do

(Continued from page 149)

despite the fact that lights were constantly shifted about to deceive them. A principle demonstrated in this test was also verified in another upon rats by Dr. J. A. Gengerelli, of Yale University—the "Law of Least Effort." He showed that rats crossing a box to reach food will soon discover and thenceforth follow the shortest route from corner to corner—a diagonal straight line.

Psychology Put to Work

A REVISED jury system, a better way of putting advertisements in magazines, and advice to actors playing emotional scenes are latest suggestions for the practical application of psychology.

Advertisements need not be mixed with magazine stories, declared Dr. Harold Burtt, of Ohio State University. He prepared two "dummy" magazines. Each contained twenty pages of advertising and twenty-five of reading matter. In one the advertising and reading pages alternated. In the other they were in separate sections. Subjects remembered the "ads" equally well after looking through each for ten minutes.

Present-day juries should be abolished, declared Prof. Harry Elmer Barnes, of Smith College. A board of examiners, most of them psychologists, should try criminals.

Mental disorders predispose many to crime, said Dr. F. A. Moss, of George Washington University. A criminal record may be an "accidental expression" of a person's mental condition, agreed Prof. Joseph Jastrow, of New York.

A stage actor portrays emotion best when he keeps just aloof from it, said Prof. John T. Metcalf, of the University of Vermont. A vivid mind-picture of anger or love serves the actor better than the sensation itself.

Drugs and Moonlight

STRANGE effects of the Oriental drug hashish, made from the flowers and leaves of Indian hemp, were described by Dr. Erich Lindemann, of the University of Iowa. Observers who volunteered for tests of hashish intoxication found that their sense of touch, in particular, was strangely altered. A small object repeatedly handled seemed to swell to huge size. Another common form of illusion was distorted judgment of elapsed time.

Dr. David I. Macht, of New York City, reported that exposure to polarized light caused death to drugged rats, while other drugged rats exposed to ordinary light recovered. He treated rats with camphor or cocaine—two drugs producing convulsions of the brain. The polarized light, which differs from ordinary illumination in that its light waves vibrate in a single plane instead of helter-skelter, made the convulsions fatal. The results were particularly interesting because natural moonlight, once popularly believed to "make people crazy," is known to be largely polarized.

Man and Woman

MARRIAGE makes a man's mind more feminine, Prof. L. M. Terman, of Stanford University, declared in a paper he submitted to the Congress. Having analyzed masculine and feminine traits in the minds of large groups of men and women, he reported that environment often plays an overwhelming part in shaping them.

A "he-man" in appearance may be more feminine in thought than the average woman, he said, since physical appearance has nothing to do with the mind in either sex. After a few years of marriage husbands, he found, are likely to take on a more feminine outlook in interests, preferences, and emotional reactions.

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Welding—the Silent Builder

(Continued from page 31)

special screens are used to eliminate ordinary light, and with it the obscuring haze. Only penetrating invisible rays of infra-red light are used to take the picture. In this way successful motion pictures were made of the operation of welding. They showed exactly how a drop of metal interrupts an electric arc when it touches the weld, and how it spreads out to fuse with the metal. From such photographs, three of which are reproduced on these pages, improved welding methods are foreseen.

In the early 1900's a welder announced: "We do the impossible. We weld cast iron." Steel was then the only metal ordinarily welded. Today any known metal in commercial use can be welded, as evidenced by copper tanks, bronze statues, and aluminum coffee pots. Nearly all welding today is done by one of four methods—two electrical, one by gas, and one by chemicals.

ARC welding, an electric process, uses the heat of an electric arc to produce a flow of liquid metal to form the weld. The heat of the vapor forming the arc reaches the temperature of six or seven thousand degrees Fahrenheit. The light from the arc is blinding. An arc welder wears a hood that calls to mind the armor of medieval knights. Its window is a special screen of glass so dark that nothing may be seen through it except while the electric arc is on. A spray of molten metal sparks flies from work being welded with the aid of the arc, which is really a flame of hot gases. One terminal of the electric circuit is the welding rod itself; the other is the work to be welded.

To start the work, an arc-welder, holding in his shielded hand a rod electrically wired, lightly touches it to the joint to be welded. This closes the electric circuit, and the welder creates the arc by moving the rod a fraction of an inch away from the piece to be welded. The heat of the arc keeps the rod melting. The welder slowly draws the arc along the joint, which becomes filled with metal from the melting rod. The work-piece itself is also partly melted by the heat, making a perfect fusion with the rod's metal. This method of welding, which can also be performed by a welding machine, is especially adapted to mass production of metal articles, as well as to structural work. Not everyone knows that arc-welding is the oldest form of all. It was first tried in France, in 1881, for joining parts of storage battery plates.

OXY-ACETYLENE, or gas-torch welding, uses the 5400-degree flame of acetylene gas and oxygen burning fiercely at a blowpipe's tip to fuse and weld metal. A rod of suitable material held in the flame supplies the extra metal needed for the joint. Although not as intense as the electric arc, the light of this flame would blind an operator in time if he did not wear protecting dark goggles. Some idea of the violence with which the oxygen supports combustion of the gas is given by odd experiences of veteran welders. Cases are on record where the valve of a tank of compressed oxygen, used on welding, has leaked, oil present somewhere has caught fire by spontaneous combustion, and soon the brass valve has itself caught fire and showers sparks under the tremendous oxidizing power of the oxygen stream.

Gas-torch welding is a widely used hand method, especially for repair work. It is adapted to welding small metal pieces. The first workable oxy-acetylene torch was developed by two Frenchmen, Fouche and Picard, in 1900–1901.

"Thermit welding" and "spot welding" are the two other principal methods, each with a rather restricted but important application. More like a Fourth of July celebration than an industrial operation seems a thermit welding job, to a layman's eye. *(Continued on page 152)*

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Welding—the Silent Builder

(Continued from page 151)

This chemical welding process consists of placing a crucible filled with "thermit," a mixture of iron oxide and metallic aluminum, above a mold containing the pieces to be welded. A piece of red-hot iron or a match is used to ignite an inflammable powder which, in turn, ignites the mixture in the crucible. A fierce reaction follows. Showers of sparks, resembling the "flower pots" used in fireworks celebrations, are tossed off from the seething crucible. Molten iron pours from the bottom of the pot into the mold, where it fuses with the metal to be welded. This method is particularly applied to bulky welding operations. It has been used successfully to weld breaks in large shafts, castings, and the sternposts of vessels.

SPOT welding, used for "tacking" together large sheets of metal at spots along their edges, is an electric method that differs radically from arc welding. It applies heat from the inside of the work instead of from the outside. Metal sheets are clamped in a press which shoots an electric current of low voltage but tremendous amperage through them. The metal's own resistance to the current instantly fuses it at the points of contact. Machines have been developed that do spot welding at high speed.

Not long ago the General Electric Company, after researches conducted by Dr. Irving Langmuir, noted physicist, announced a novel method of welding—"atomic hydrogen welding"—to be added to the standard processes. By its means, hitherto unweldable metals can be melted and fused without the slightest trace of oxidation, and welding can be performed in some cases on metal as thin as a sheet of paper. Briefly, this method utilizes the passage of a stream of hydrogen through the arc between two electrodes. The heat of the arc breaks up the hydrogen molecules into atoms. These atoms recombine a short distance beyond the arc into molecules of the gas, and this process liberates an enormous amount of heat, so that more effective welding temperatures can be obtained than with the ordinary welding methods.

The apparatus for this process was developed for commercial use in 1927. Its principal feature is the torch with which the actual welding is done. This consists of a holder supporting two tungsten wire electrodes, electric conductors connecting the electrodes to a reactor, and tubing for the hydrogen gas. Each electrode is supported on a nozzle through which the hydrogen gas is forced out around it. The electrodes are set at an angle, and the distance between the electrodes is adjustable, as is the flow of gas.

ATOMIC hydrogen welding differs from other methods in that there is no flow of current from the electrodes to the work to be welded. The electric conductors to and through the torch are heavily insulated, and, when welding ceases, the welding current is automatically interrupted until the operator is ready to weld again, when the circuit is automatically restored.

The most important feature of the hydrogen process is the absence of oxidation from the welded metals. Since atomic hydrogen is a powerful reducing agent, it reduces any oxides that might otherwise form on the surface of the metal. Because of this absence of oxides and nitrides from the weld made by it, this process is particularly adaptable to the welding of special alloys—such as those of chromium, nickel, copper, aluminum, and silver—and will also make a strong, smooth, and ductile weld on ordinary iron or steel work.

Startling as are some of the present uses of welding, researches such as these may disclose still other useful applications.

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Here Are Correct Answers to Questions on Page 55

1. The human eye is practically a miniature camera which has a lens, an iris, and a retina, the sensitive nerve surface that registers the light impression. If, through some structural or muscular error, the lens does not focus the image on the retina, vision will not be clear and glasses will be needed to correct the condition.

2. Astigmatism is an optical distortion caused by an improperly formed cornea. The cornea is the spherically shaped glasslike surface at the front of the eye. If this surface is not a section of a true sphere but is curved more in one direction than in another, the image formed on the retina will be sharp only in the lines of the image running in one direction. If such an eye observes a chart consisting of lines radiating from a central point, only one set of lines at one particular angle will appear sharp. The angle, of course, will depend on the direction of the irregularity in the cornea. The glasses used to correct this condition are ground plain on one side and curved like the section of a cylinder on the other to neutralize the distortion produced by the irregularity in the eye structure itself.

3. The human eye lens, like a camera lens, can focus objects sharply at only one distance from the eye at a given instant. When the eye is directed toward other objects farther from or nearer to the eye, the focus of the lens must be changed. This changing of focus is called accommodation, and is accomplished by muscular action in the eye. As people grow older the accommodation becomes poorer owing to deficient muscular action. It frequently happens, therefore, that an older person cannot focus sharply objects either far away or close at hand. Two pairs of glasses are needed, or a single pair of the so-called bifocal type, in which the lower section corrects for reading and the remainder of the lens for distance.

4. An eye that is nearsighted is unable to focus objects at some distance from it. Technically, this trouble is known as myopia. It can be corrected by a lens ground flat on one side and curved inward on the other, so that light rays from distant objects are dispersed through the lens of the eye as though they came from nearer objects.

5. A flat-shaped lens gives the proper correction only for objects directly in front of the eye. As the eye is turned in its socket the light rays are sent through in a diagonal manner away from the center, and distortion results. Toric lenses are ground in curves. One side usually is a section of a perfect sphere and the other side is a section of a sphere to which the correction for the eye trouble has been added or subtracted. The toric lens is desirable because it gives a wider angle of distortionless vision.

6. The human eye is designed to be in constant operation at all times during waking hours. In fact, the eye is always in use so long as the eyelid is open. Of course, the reading of very fine type, especially in poor light, and certain types of work requiring extreme visual concentration, such as drafting, fine sewing, and so on, put a continual strain on the eye. There is, however, no definite limit to the use of the eyes, as it varies with different individuals.

7. Assuming that the eye trouble is purely optical and is fully corrected by the lenses of the eyeglasses, there is no difference in light requirements for a person with glasses and one with eyes not requiring glasses. In any case, the light should come over the shoulder and in ample volume for (Continued on page 154)

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M322

Here Are Correct Answers to Questions on Page 55

(Continued from page 153)

distinct vision, but not in such great quantity as to cause glare.

8. Farsighted eyes are so constructed, or the muscular control is such, that it is impossible for the eye to focus sharply on near-by objects. Eyeglasses that are worn to correct this trouble are ground flat on one side and bulging outward on the other. The use of such a lens collects light from points on objects that are near by and projects them through the lens of the eye just as though they came from more distant objects.

9. If the defective vision is due to serious optical trouble there is no cure. Nearsighted people have a tendency to see distant objects more clearly as they grow older. Prolonged living in the outdoors with no close work for the eyes has a tendency to correct nearsightedness.

10. It is always better to use eyeglasses properly ground to correct the vision to normal. Of course, on very fine type such as is found in older Bibles, encyclopedias, dictionaries, and so on, the use of a large-diameter reading glass frequently is helpful, in addition to the use of proper eyeglasses.

A Well-Built House Is Cheapest

(Continued from page 75)

You may want to sell some day, and that's one of the details that helps to hold value. Good plastering is another. You are going to use metal lath all over, but I've lately been specifying a kind that I like better than the ordinary varieties because it does more. It is welded wire mesh backed with some kind of sheeting which is much heavier than building paper, and behind which are stiffening ribs that keep it flat as a board. When the plaster goes on, the sheeting runs it together to form a solid slab with the wire in the center, and you get plaster walls that are reinforced and made air-tight by the sheeting."

"All of that sounds good to me," said Bob. "After hearing of Ed's experiences I want my house to be as proof against grief as you can make it. But about that house that you saw where the piano went through the floor. The owner held the builder for it, didn't he, and forced him to make good?"

"HE TRIED to, but he couldn't. There's no guarantee on a house, you know; you buy as is, and as soon as your name goes down on the dotted line you become responsible for it. There are builders who have enough pride in their work to make good when anything goes wrong, but they are the kind who put up houses that don't give trouble.

"It's the same when you build. The work should be inspected as it goes along, to make sure that the specifications are being followed and that the workmanship is what it should be. If the builder is trying any funny business, that is the time to catch him; for if he puts something over and you don't find it out until after you have accepted the job, it's up to you. You can't hold him."

"Well," said Bob, "someone told me the other day that the soundness of a house depends on the honesty and moral worth of the builder, and what you say proves it."

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High Speed Skyways 14 Miles Up

(Continued from page 27)

ity theorist, approve the idea on theoretical grounds. As for putting it into practice, the great Junkers airplane firm of Germany is now tentatively planning super-airliners capable of navigating the upper air levels. These would have air-tight passenger cabins supplied with air at comfortably normal pressure, and supercharged motors to enable them to fly miles above the earth.

Detailed designs for these craft are closely guarded. But a concrete picture of what a high-altitude plane would look like is given by B. V. Korvin-Kroukovsky, chief engineer of a College Point, N. Y., airplane firm. Its design, he says, would be influenced by the two greatest problems of high-altitude flying—those of providing normally thick air for passengers, and of feeding normal air to the motor of the plane.

A BARREL-SHAPED cabin fuselage of duralumin, with air-tight joints, would be the most radical feature of the 425-horsepower, five-passenger plane whose design he projects. To it air would be supplied at normal sea level pressure by a wind-driven compressor. Since theory would require a supercharger of impractical size to supply compressed air to the motor, three or four superchargers of standard type would be used instead. These blowers would be run by the energy of the exhaust gas, as in certain standard supercharger types used today, notably that recently invented by Dr. S. A. Moss, of the General Electric Company. Another unusual feature of the high flying craft would be a thirteen-foot, four-bladed propeller, its unusual size serving to obtain a grip on the extra-thin air. Such a craft, Korvin-Kroukovsky declares, could navigate at a height of eleven miles or more above the earth, where the sky is probably almost black and the stars are plainly visible while the sun is shining. Its normal speed would exceed 200 miles an hour.

The possibility that airplanes might find free fuel at still greater heights is also suggested by this expert. At a height of about 35,000 feet, he estimates, the atmosphere begins to divide somewhat into layers, due to the difference in weight of the oxygen, nitrogen, and other gases of which it is a mixture. One of these gases is hydrogen, of which only a trace is found at the earth's surface on account of its extreme lightness. Colors of the polar lights show it abundant at high levels. At a height of about 200,000 feet the proportion of hydrogen to oxygen in the air probably is such that they would burn with explosive violence, if the mixture were less rarefied. No doubt this is all that prevents a terrific celestial explosion whenever a flaming meteor falls through the hydrogen layer.

A PLANE capable of rising to 200,000 feet, Korvin-Kroukovsky estimates, could remain aloft indefinitely by burning the compressed gas as fuel, and could travel anywhere at a speed of perhaps 3,000 miles an hour. But there is a catch in this happy possibility which is not soon to be solved—to reach such a height a plane would require forty times the minimum power it would use in flying at sea level. Such a power range is a remote aeronautical prospect. More nearly practical is the 75,000-foot altitude plane with its supercharged gasoline engine and its air-tight cabin.

"I believe that an airplane capable of reaching this height will be built within the very near future," Korvin-Kroukovsky declares.

Recent medical studies show that not lack of oxygen alone, but the direct effect of the reduced pressure of thin air, causes human discomfort at high altitudes. In this lies the reason for the "pressure cabin" proposed in all plans for high-altitude aircraft. Such a device may seem fanciful,

(Continued on page 156)

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High Speed Skyways 14 Miles Up

(Continued from page 155)

yet such a cabin was actually constructed for altitude flights, and tested a few years ago, by the United States Army Air Corps. Only a minor defect in its mechanism prevented its further use.

This steel chamber, barrel-shaped and practically air-tight when its round, twenty-two-inch door was closed, was built into an altitude plane at McCook Field, Dayton, O. A small wind-driven compressor pumped air into it, and a relief valve above the pilot's head could be opened by hand to relieve the pressure at the pilot's discretion. The device was given for test to Lieut. John A. Macready, veteran altitude flyer then of the Army Air Corps.

It very nearly became his coffin. Macready squeezed through the narrow door into the barrel-shaped cabin. With a plate glass window in the door his only means of seeing the outside world, he took off. The plane climbed a few hundred feet. Then to Macready's alarm his ears began to ring with pressure more intense than had been expected. He opened the relief valve. It could not let out the air as fast as the compressor was forcing it in. He tried to open the door, but the pressure was too great. The airman faced the novel terror of being blown up from the outside in.

THERE was no way of stopping the compressor, which was driven by the wind outside. Macready throttled the engine and coasted back toward the field as slowly as he could to minimize the pump's effect. He made a rough-and-ready landing, and a second later the pressure in the cabin went down automatically with the stopping of the compressor. He was helped out none the worse for his exciting experience. The plane and its cabin were relegated to a museum. But, with a more practical arrangement of valves, such a cabin might be adapted for future altitude airplanes. Its air-tight construction, incidentally, would keep an ocean plane afloat for hours or days in the event of a forced landing.

Another possibility is an individual "pressure helmet" similar in appearance to a diver's headgear, in which oxygen or air would be supplied to the pilot or passenger at sea level pressure when an airplane was flying at a great altitude. This device, suggested by Lieut. Apollo Soucek, Navy flyer and holder of the world's seaplane altitude record, may be tried out by him in a future altitude attempt.

ALL these proposals relate to the use of airplanes somewhat similar to those of conventional design to navigate the stratosphere. But a future possibility suggested by some inventors is that of using rocket vehicles to navigate the stratosphere, the hydrogen and other layers above, or even outer space itself to the moon and beyond. In defence of such a visionary plan its supporters point out that a rocket does not depend upon thin air, or any air at all, to propel and sustain it in flight. It kicks itself along by the force of recoil of its own explosions, and would travel better in utterly empty space than in the atmosphere.

The rocket plane of forty-foot wing spread which Fritz Von Opel flew for a mile was launched from a steel track. Two of the dozen rockets were used for the start; three more gave the machine the extra impetus that enabled it to leave the earth after a run of only thirty seconds. Four that remained propelled the craft in flight. The pilot touched them off in succession by electric wires. Gunpowder supplied the explosive kick of the rockets, though Von Opel is experimenting with liquid explosive for future models.

Another rocket experimenter is Prof. Herman Oberth, an Austro-German, who recently announced that a thirty-three-foot model of a rocket (Continued on page 158)

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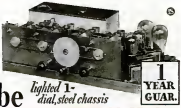

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High Speed Skyways 14 Miles Up

(Continued from page 156)

car designed by him was to be built and tested at some point on the coast of the North or Baltic Sea. One use of such a rocket, he has claimed, would be to carry air mail across the Atlantic in thirty minutes. The first model, a trial machine, was to be propelled by carbon shafts burning violently in liquid oxygen. He expressed the hope that it would reach an altitude of thirty miles or more above the earth. German naval authorities insisted that he point it out to sea, fearful of damage if it fell inland. Future models he planned, to be propelled by the exploding gases of liquid oxygen and benzene or alcohol, were a craft that would soar over and photograph unexplored regions of the earth, and a 136-foot "space ship" for a flight to the moon.

Commenting upon these projects and the flight of the powder-driven Opel rocket plane, Professor R. H. Goddard, of Clark University, declares, "A plane equipped with powder rockets has an extremely limited cruising radius unless it is used as a rocket glider. If, on the contrary, liquid propellants are used, some surprising distances can be covered in a shorter time than with an ordinary plane."

Experiments with liquid explosives which Opel and Oberth have proposed are unnecessary, Professor Goddard says. His work under the Smithsonian Institution has already produced liquid-propellant rockets that work.

A nine-foot trial model of a rocket of this kind which he designed nearly caused a panic when it soared over Worcester, Mass. (P.S.M., Oct. 29, p. 24). One of Professor Goddard's immediate and practical aims is to provide a device that can be sent aloft to a great height with weather instruments which will return at once, via parachute, and provide records to guide high-flying aviators.

"Jet propulsion," a novel form of power in which cool jets of gas at high pressure would drive an airplane, offers still other future possibilities. So far it has not been applied to airplanes. But a jet-driven automobile invented by Max Valier, German aviator and experimenter with rockets, recently traveled thirty-seven miles an hour in a trial at Essen, Germany. Gas spurted with a hissing noise from three pressure tanks of steel, behind the driver's seat, in which it was kept liquefied. Eventually airplanes, too, may use this form of power and soar to new heights.

Whatever way airplanes may take to reach and navigate the stratosphere, it seems as if this will be the next great step forward in aviation. Sooner than most persons believe, airplanes may cross oceans in a few hours, and soar so high that powerful telescopes cannot discern them.

Sunshine in Candy

"CANDIED sunshine" is the latest remedy for tuberculosis, anemia, and rickets. Two Viennese scientists claim to have found a way to irradiate chocolate with ultra-violet light in such a manner as to cause no loss or change in flavor. The investigators first experimented with rats, which increased in weight after eating the chocolate. This result might, of course, also have been obtained with ordinary chocolate. More important and convincing, however, were tests with human patients, who are said to have improved in appetite and their blood after eating it.

A process of irradiating cereals has been perfected in this country by Professor Harry Steenbock, of the University of Wisconsin. The inventor patented his process and then presented it to the University, which now licenses breakfast food manufacturers to use it on condition that they do not raise the price of their product. (P.S.M., Feb. '29, p.47).

First Victories in War on Fog

(Continued from page 25)

have been designed to tell flyers their height above the ground by the time required for sound waves or radio waves to be reflected back from the earth to the airplane.

At sea, the radio compass protects vessels from crashes and allows them to determine their position in a blinding fog. It indicates the direction of a radio signal, thus warning of the approach of other vessels moving through the fog, and giving the direction of points on land. A new invention in England enables the captain of a fog-bound boat to detect faint sounds of distant fog sirens as he edges toward the shore. The device picks up the feeble sounds, amplifies them, and also converts them into light signals which appear as small light spots on a screen.

Another phase of fog fighting is concerned with efforts to dispel the low-lying clouds. Two experiments in fog dispension conducted in recent years in America have given some promise of success. At the Government aircraft factory in Philadelphia, Pa., the Navy Bureau of Aeronautics conducted a series of ingenious demonstrations. Into a specially-constructed room, with brilliant lights shining on the wall opposite an observation window, were introduced clouds of man-made fog. The lights were all but obscured by the dense vapor. Suddenly a dozen jets sprayed highly electrified water into the room. The fog vanished as though by magic and the lights blazed forth as brilliantly as before.

More spectacular was the performance of a "cloud eating airplane" which Dr. L. Francis Warren, of Harvard University, sent aloft at Bolling Field, Washington, D. C. some years ago. Equipped with tanks of fine silica sand and apparatus which charged the grains with electricity as they were sprayed through a nozzle, the machine climbed above a cumulus cloud. As it passed across the cloud, the trail of electrified sand ate a deep chasm in the fog. When the plane cut figure eights, the sand traced the evolution as easily as a blowtorch would eat its way through a snowbank. Then the pilot circled around and around, letting sand grains carve out a deep well in the mass of mist. From the bottom, the flyer said he could look up and see high white walls rising on all sides, with the blue sky far above.

The secret, Dr. Warren explained, was that the electrical charges of the sand grains were opposite in polarity to those on the water particles in the fog. Instruments on the plane showed whether the cloud was charged positively or negatively and the apparatus for spraying the sand could be set to give it an opposite charge. The water particles were attracted to the sand grains, forming large drops that fell as rain. This explanation also accounts for the disappearance of the fog in the laboratory room of the Bureau of Aeronautics, in Philadelphia. The electrified water particles sprayed into the room attracted the fog droplets having charges of the opposite sort of electricity.

"Cloud-eating" airplanes have demonstrated effectiveness on a small scale. Whether they will be of practical value over large areas only additional and costly tests can answer. The machines used at Bolling Field spread only thirty pounds of sand a minute. Dr. Warren declares that two or more planes capable of spreading 1,100 pounds a minute could dispel fog over an area the size of London.

Since the airplane has taken its place as a recognized means of transportation, the problem of conquering fog assumes new importance. Whoever can find the key to controlling it will be ranked with the great servants of mankind.

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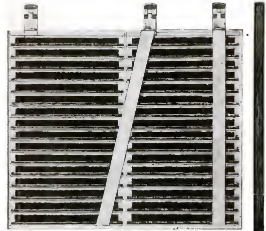

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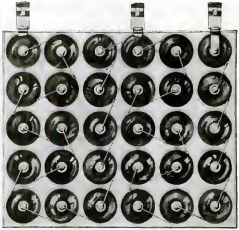

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One diagram shows the old cylindrical cell type of battery. Note the 29 fine wires, and the 60 delicate solderings—89 places where trouble can come. We make such batteries as well as they can be made, but we also make a much better kind—the unique Eveready Layerbilt.

See the Eveready Layerbilt diagram. Note the *flat* cells of which it is built. Those cells are not independent, needing soldered connections, but *inter*dependent, making connection with each other automatically. To join the two sections, but two broad connecting bands are needed, each ⅜ inch wide. There are but five husky, trouble-proof solderings. And to cap the climax, the flat cells pack more active materials within the battery, and so you get longer life, greater convenience and economy.

Eveready Layerbilts are the best batteries made, and no other battery is like them. You can make "B" batteries out of separate cells of any shape you choose, and still you cannot imitate the Eveready Layerbilt. It is patented, and exclusive with us; our invention, and *your* advantage in economy, convenience and satisfaction. Be sure you get Eveready Layerbilts. Look for the name printed large on the label.

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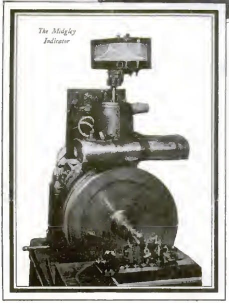

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THE famous Midgley Indicator was devised to enable the scientists in General Motors Research Laboratories to look inside the closed cylinder of a gasoline engine. It tells exactly what happens in that tiny fraction of a second when gasoline explodes.

The Midgley Indicator is an ingenious and sensitive mechanism which records the pressure inside the cylinder while the engine is running. By studying these pressures the scientists found out exactly what caused an engine to "knock." In fact, they found it was not the engine at all, but the *fuel* which "knocks."

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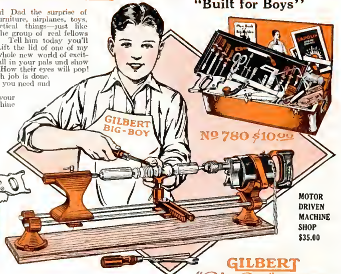
"Built for Boys"

BOYS, here's your chance to give Mother and Dad the surprise of their lives! Build with your own hands furniture, airplanes, toys, bird houses, and hundreds of other practical things—just like skillful builders do. Tell Dad you want to join the group of real fellows who build things with Gilbert "Big Boy" tools. Tell him today you'll start right in as soon as you get your Big Boy Set. Lift the lid of one of my big red brass-bound tool chests and you open up a whole new world of exciting thrills. Put on the sporty carpenter's apron, call in your pals and show them how a real builder goes to work. Oh, Boy! How their eyes will pop! My Boy Builder's Plan Book tells exactly how each job is done. And there's a tool for every purpose. I know what you need and I've built these tools especially for you.

Find out right away how smart you are with your hands. Look over my Big Boy Tool Chests and machine shop outfits at any good store. Take Dad along. Tell him you want to be a full-fledged member of this happy group of builders. Pick out your set, get it home quickly, and start right in building wonderful things.

A. C. Gilbert

When You Buy Your Tool Chest
See that you get these
Feature Tools



Let's Go

If you want to make things hum, the thing for you is my brand new Motor-Driven Machine Shop, the greatest thing I've made for boys since I invented Erector. Yes sir, it's a complete scientific work shop for the amateur—a combination portable lathe, demountable drill, emery wheel for grinding knives and sharpening tools. There's a real scratch brush for removing rough surfaces from metal, and a buffing wheel for finishing and polishing metal And—Boy, here's news—this workshop's equipped with a ⅛-H.P. Universal Motor and A.C. or D.C., with toggle switch, cord and plug. It would take a whole page to tell you everything about this marvelous outfit. Send that coupon in to me and get the booklet that tells you all in words and pictures.

Boys

This big chest of tools (Number 780) is the treasured possession of thousands of red-blooded boys. They wouldn't swap it for a million dollars. But you can get yours at any good store. There are 26 pieces in all—18 pounds of scientific fun—the kind of fun you'll never get tired of. A saw that bites its way through wood, a plane that shaves like a master, a brace and bit, chisels and dozens of other he-man tools for the boy builder. And two complete books that show clearly and exactly how to build hundreds of wonderful useful things. Now boys, be sure you get my big red brass-bound BIG BOY Tool Chest, because I know what you need and have spent ten years planning this fun for you.

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2. All metal spirit level in No. 785 and up.
3. Ground faced block plane in No. 765 and No. 780.
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5. Sapolin color chart, Home Manual, Plan Book and Sapolin Speed Enamel, in all Dad's Size chests.
6. New 1929 Plan Book in all sets.
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Household Treasure Chest No. 780. 26 pieces of he-man tools including big 16-inch cross cut saw and 7¾-in. plane. A regular outfit. Two plan books and color chart. Packed in brass bound chest. Sapolin Speed Enamel.......... **$10.00**

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The DeLuxe Carpenter Set No. 790. Feature set of Big Boy line. 37 pieces including 9-in. plane, ratchet brace, 15-in. level, 20-in. cross, 18-in. rip, and dandy keyhole saws. 2 plan books and color chart. Packed in big red chest, brass corners and lock. Sapolin Speed Enamel. **$25.00**

BOY'S SIZE

Little Fellow's Set No. 701. Contains 11 pieces with plan book. **$1.00**

Dandy Big Set No. 701E. The set for the beginner. Contains 12 pieces with plan book.......... **$1.50**

Practical Young Carpenter's Set No. 702. 10 pieces with plan book.......... **$2.50**

Handy Set No. 707. Practical set for boys, 19 pieces including plan book.......... **$3.50**

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